No 3/1981

Canada Agriculture

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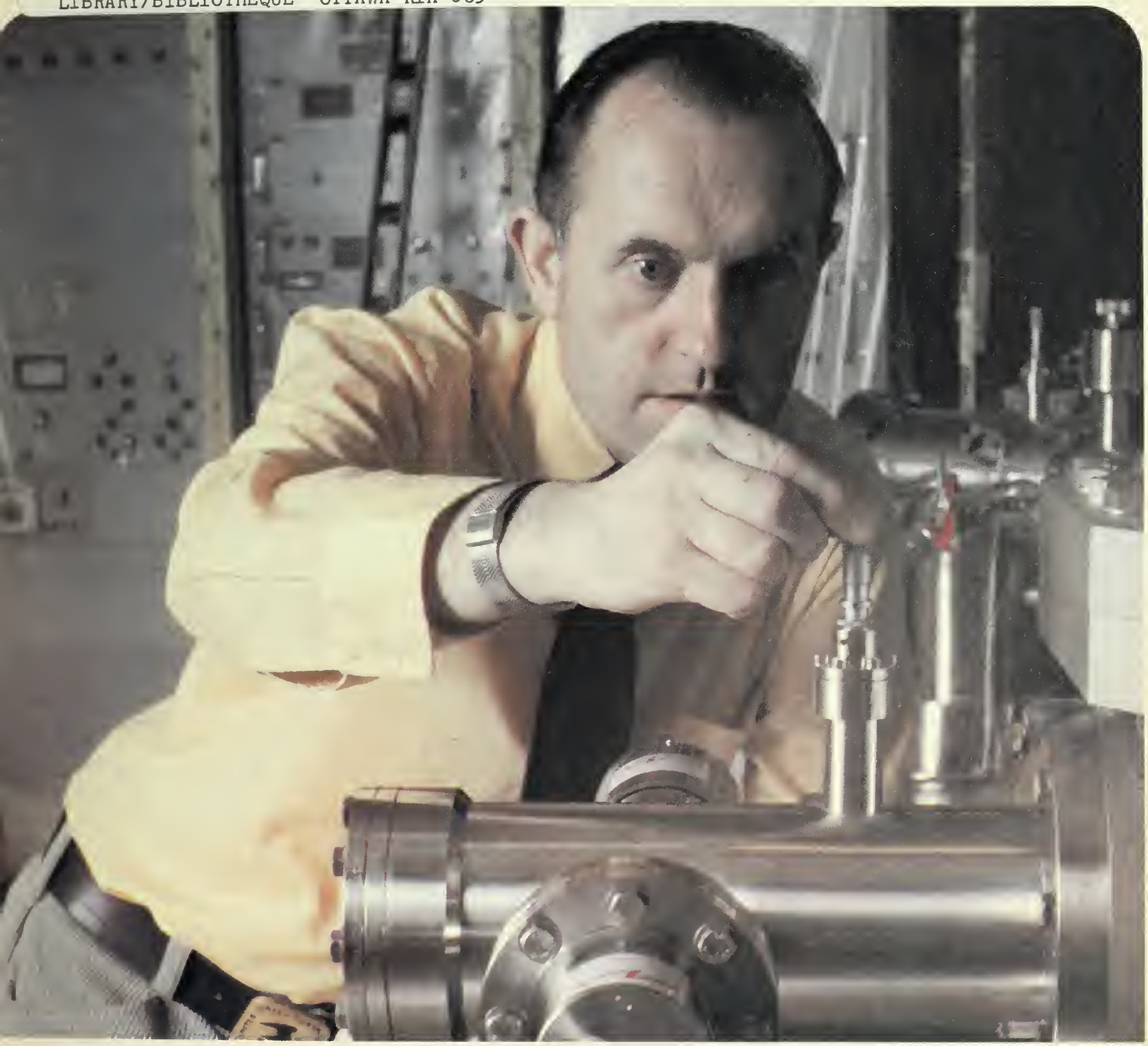

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Cover photo

Photo de la page couverture

Agriculture Canada scientist Dr. Bill Cochrane tuning a high resolution mass-spectrometer.

M. Bill Cochrane, scientifique au service du ministère de l'Agriculture, en train de mettre au point un spectromètre de masse à haute résolution.

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COMMENTARY / COMMENTAIRE

Public Services

Agriculture Canada's Public Services Section provides agricultural information to the public, the department, and agri-business through its Technical Liaison and Distribution Units.

The information officers of the Technical Liaison Unit handle a large volume of inquiries. The requests, which are usually for technical information, are answered by telephone, letter, personal contact, or by departmental publications. The Distribution Unit fills orders for more than 3 million publications a year.

The Public Services Section also conducts seminars, briefings, and guided tours, which often include foreign agricultural groups. The staff also give talks on departmental programs to extension and farmer organizations, judge at fairs, and act as resource people at exhibits. The section is consulted regularly by the media and participates in more than 150 radio and television programs each year.

Public Services prepared Food Price Dialogue, an audio-visual kit, for community organizations and extension workers in the field of food, nutrition, and consumer affairs.

One of several programs with which the section is actively involved is Telidon, the easy-to-use graphics communications (Videotex) system. This summer, Agriculture Canada participated in the Manitoba Grassroots project, which used Telidon as an agricultural business planning tool for nearly 30 000 producers.

Because of Public Services' wide exposure, it plays a prominent role in shaping Agriculture Canada's image.

Services des relations extérieures

Les services des relations extérieures du ministère de l'Agriculture du Canada renseignent le public, les ministères et l'agri-négoce sur les questions agricoles par l'intermédiaire des Sous-sections de l'information technique et de la distribution.

Les agents d'information de la Sous-section de l'information technique répondent à de nombreuses demandes, habituellement d'ordre technique, par téléphone, par correspondance, de vive voix ou par le biais des publications du Ministère. De son côté, la Sous-section de la distribution assure la diffusion de plus de trois millions de publications chaque année.

Les Services des relations extérieures organisent également des séminaires, des séances d'information et des visites auxquels participent souvent des groupes provenant de l'étranger. De plus, son personnel donne des conférences sur les programmes du Ministère aux associations d'agriculteurs et de vulgarisateurs, agit en tant que juge à des foires et sert de personne ressource lors d'expositions. Les média consultent régulièrement le personnel de la Section, qui participe à plus de 150 émissions de radio et de télévision chaque année.

Les Services des relations extérieures ont préparé un montage audio-visuel intitulé "Dialogue sur le prix des aliments", pour les organisations communautaires et les vulgarisateurs qui s'intéressent à l'alimentation, la nutrition et la consommation.

Un des programmes auquel participe activement la Section est Telidon, système de communication graphique (Vidéotex) facile d'emploi. L'été dernier, le ministère de l'Agriculture du Canada a participé au projet Grassroots du Manitoba, qui regroupait près de 30 000 producteurs et se servait de ce système comme outil de planification pour les entreprises agricoles.

Mr. Maurice Tessier, Chief, Public Services.

M. Maurice Tessier, Chef, Services des relations extérieures.

Mechanical bloodhounds

V. Meere

A gas chromatograph-mass spectrometer is a mechanical bloodhound that never fails when given the scent. It can detect even the slightest trace of a chemical 'suspect' — at levels as low as a few parts per trillion.

Scientists at Agriculture Canada's Food Production and Inspection Branch are using gas chromatography-mass spectrometry (GC-MS) as the essential tool in backup research in the continuing review of pesticides and as the definitive answer-giver in solving food-contamination crises.

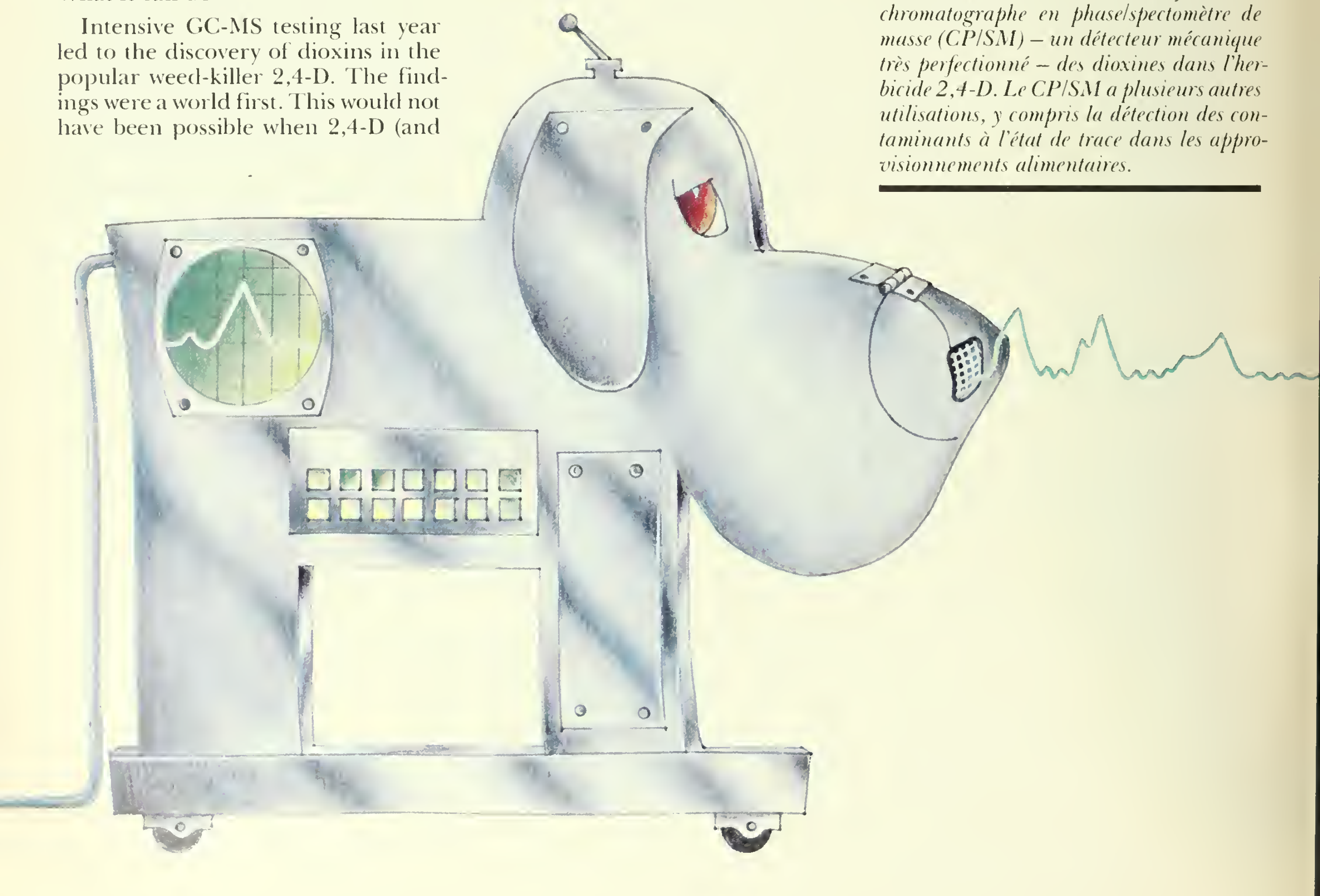
What it can do

Intensive GC-MS testing last year led to the discovery of dioxins in the popular weed-killer 2,4-D. The findings were a world first. This would not have been possible when 2,4-D (and other pesticides) was first registered about 40 years ago by Agriculture Canada. At that time too, the knowledge about pesticide hazards was not as extensive as it is today.

A classic application of GC-MS led to the identification in 1980 of vomitoxin in Ontario winter wheat and in Quebec spring wheat crops. Eliminated as the culprit was another mold toxin called HT-2. Vomitoxin is not as serious a contaminant as HT-2, but when present in livestock feed in sufficient quantities it can cause vomiting, feed refusal, weight loss and reduced performance.

Also in 1980, inspectors from the Canadian Grain Commission had noticed a higher-than-normal percentage of Ontario white winter wheat kernels stained pink. They asked the Agriculture Canada Research Station in Winnipeg to test samples of the

Les scientifiques de la Direction générale de la production et de l'inspection des aliments d'Agriculture Canada ont découvert, l'année dernière, au moyen d'un chromatographe en phase/spectomètre de masse (CP/SM) – un détecteur mécanique très perfectionné – des dioxines dans l'herbicide 2,4-D. Le CP/SM a plusieurs autres utilisations, y compris la détection des contaminants à l'état de trace dans les approvisionnements alimentaires.



grain. These tests indicated a high level of HT-2. This led to an embargo on exports of all but the top grades of an 800 000-t crop. But further testing by GC-MS in Ottawa found a correlation between the pink kernels and vomitoxin. While the wheat from Ontario — and later Quebec — was judged unfit for human consumption, safe levels of the grain as a feed mix were established. And the export embargo was lifted, provided buyers were made aware that lower grades might contain mycotoxins.

GC-MS in 1979 established the level and type of polychlorinated biphenyls (PCBs) in some poultry, eggs, milk, and livestock feed in British Columbia. One consequence was Agriculture Canada's ordered destruction of a shipment of 1374 pheasant carcasses. The PCB contamination was discovered as part of a widespread government trade-and-test program, which began with the discovery of PCBs in supplies of animal tallow used to manufacture livestock feed by mills in Abbottsford, British Columbia. The contaminated tallow originated in a Montana livestock processing plant, site of a PCB spill from an electrical transformer. GC-MS tests of the pheasants found PCB levels high enough to pose a health threat. Milk samples were negative. Some low levels of PCBs were found in chickens, turkeys, feed, and eggs.

Agriculture Canada scientist Bill Cochrane injects a herbicide sample into a sophisticated gas chromatograph-mass-spectrometer system.

Big workload

Almost any substance can be analyzed by GC-MS. This process not only identifies components in a test sample but measures how much of each is present. It's because of this capability that the five-man GC-MS unit at Agriculture Canada's Food Production and Inspection Branch's Laboratory Services Division is in such heavy demand. Work requests from sister labs — notably those specializing in seeds, feeds and fertilizers, foods, and pesticides — are snowballing. The pesticide regulators are the big client. Then too there are demands on the GC-MS unit's unique talents by other federal departments such as Environment Canada and Health and Welfare Canada.

A priority list of testing requests has been drawn up and another operator added. And a new, more versatile gas chromatograph-mass spectrometer — a $700 000 VG Micromass-ZAB-2S — provides added capacity. The new unit joins two others in the Plant Products Building in Ottawa — a Kratos MS-50 and a Finnigan 4000 MS. They were purchased 2 years ago for $500 000. The Kratos is one of only three of its kind in Canada. The machines are linked to a computer library of 25 000 compounds and two videodisplay terminals. A special printer provides readouts and graphs (Figure 1).

Just as the lab's work has mushroomed so have the demands on the time of its chief, Dr. William Cochrane, an anything-but-a-dour Scot who came to Canada 12 years ago. Dr. Cochrane is always on the go or on the phone answering dioxin queries. He has given dozens of internal talks to Agriculture Canada staff about GC-MS and dioxins, and lectures almost weekly at university departments of chemistry or at scholarly gatherings.

He thrives on his workload and role as lecturer and educator, and is determined that the GC-MS unit continues its role as world leader in keeping the food supply as free as possible of contaminants.

The 2,4-D decision

The 2,4-D re-evaluation and the GC-MS analysis were ordered in response to statements (not by Agriculture Canada) such as: "There are no dioxins in 2,4-D." No factual evidence could be found to support such a position. Under the Pest Control Products Act, Agriculture Canada is continually reviewing the safety, merit, and value of older pesticides — to gain more knowledge and understanding and to provide the best pos-

Analyzing mass-spectro data with a computer.

sible assurance of both human and environmental safety.

Canadian 2,4-D samples were selected at random from dealers or formulators. The survey focused on types of products — for example esters and amines — rather than brand names. In simplest terms the GC-MS analysis found that some samples were contaminated with certain dioxins (di, tri and 1, 3, 6, 8/1, 3, 7, 9 tetra). The study (see appendix) also showed a clear distinction among product types. For example, while the majority of amine products studied were dioxine free, virtually every ester sample was contaminated. These observations at least suggest that there is a manufacturing or process factor involved.

Based on present knowledge, Health and Welfare Canada toxicologists — with whom Agriculture Canada experts work closely in pesticide control — believe that the types of dioxins found in the 2,4-D samples are much less toxic than the 2, 3, 7, 8 TCDD found recently in herring gull eggs. This dioxin is extremely toxic and dangerous to humans. It has not been found in 2,4-D. There are about 75 dioxins, a group of closely-related chemicals consisting of two molecules known as benzene rings with chlorine atoms around them.

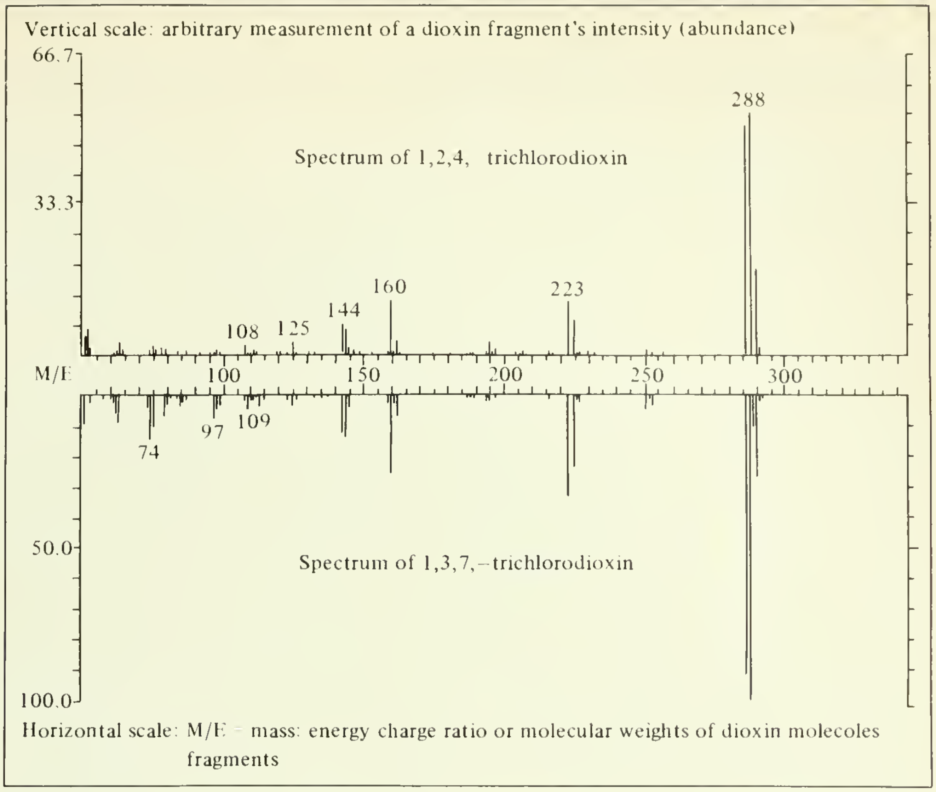
There is much controversy about dioxins and their effects. The evidence is not clear-cut. The tri and tetra dioxins discovered in 2,4-D have not been studied for their biological effects. But the potential long-term health hazards posed by dioxins cannot be denied. If it were possible to immediately eliminate dioxins, of course, that would be the way to go. Nobody has an instant solution to this one. However, Agriculture Canada has taken many steps to help the situation.

Where do we go now?

Re-evaluation of an older product does not mean that it is unsafe. However, it often means that new or additional studies may be required in some

Adjusting the mass-spectrometer before running a sample.

Figure 1. The two graphs (placed bottom to bottom) are 'fingerprints' of two almost-similar dioxins. The graphs display the data (the mass spectra of the two dioxins) provided by a gas chromatograph-mass spectrometer scan of the molecular fragments of the dioxins. Two criteria are measured and compared. The position of each peak on the horizontal axis indicates the M/E (the mass: energy charge ratio or molecular weight) of a fragment. The amplitude of each peak (on an arbitrary scale) indicates the intensity (abundance) of each mass (fragment). The pattern of peaks is a mass spectrum of the dioxin. Note that differences between the two dioxins become apparent only at the low end of the mass spectrum of each dioxin. A different method was used to detect specific dioxins in 2,4-D samples and to measure the quantity of dioxin present.



areas to meet today's health and safety standards. This reflects:

— increasing sophistication of modern chemical and toxicological (safety) testing techniques;
— tougher registration standards; and
— greater public expectations of safety testing.

Agriculture Canada and Health and Welfare Canada, working with the U.S. Environmental Protection Agency, are moving closer to a common North American position on additional 2,4-D studies that may be necessary to meet modern standards. Manufacturers are taking a similar approach to pool their resources and talents in providing more modern studies.

Agriculture Canada believes it is important to keep the pesticide debate in a logical, nonemotional perspective. It is obvious that there is a genuine public concern about all chemicals. To maintain a reasonable balance it will be essential to be visible and vocal in citing the importance of safe and effective pesticides to modern agriculture.

Appendix

W.P. Cochrane, J. Singh, W. Miles, B. Wakeford, and J. Scott

Analysis of Technical and Formulated Products of 2,4,-Dichlorophenoxy Acetic Acid for the Presence of Chlorinated Dibenzo-p-Dioxins

Laboratory Services Division, Food Production and Inspection Branch, Agriculture Canada, Ottawa

"Supplementary Note, February 1981"

Since October 1980, when the first initial findings of dioxin contamination in 2,4-D ester and amine products was made public at an international scientific meeting on dioxins in Rome, further 2,4-D samples have been analyzed. Of the 26 2,4-D amine samples tested, the majority (i.e., 18 samples or 70%) contained no dioxin contamination above the detection limit of 1 ppb. The remaining 8 samples gave dioxin results ranging from 5-409 ppb dichlorodioxin, 38-587 ppb trichlorodioxin and 20-278 ppb for the combined 1, 3, 6, 8- and 1, 3, 7, 9-tetrachlorodioxin isomers. Conversely, in the case of the 2,4-D esters all but one of the 21 samples tested contained appreciable levels of dioxin contamination. This study covered the iso-octyl ester (IOE), mixed butyl ester (MBE) and propylene glycol butyl ester (PGBE) types. Dioxin levels ranged from 104 ppb – 23.8 ppm dichlorodioxin, 35 ppb – 2.45 ppm trichlorodioxin and 120 ppb – 8.7 ppm tetrachlorodioxin. No other dioxin isomers, other than those mentioned above, were found in these samples.

Mr. Vil Meere is feature writer for *Canada Agriculture.*

Searching for the key to flowering

J.A. Simmonds

If the flowering of plants could be controlled by the application of specific flower-inducing chemicals, the benefits to agriculture could be immense. Cereal crops that could be induced to flower earlier would be ensured of completing grain development before the onset of early winter frosts. It is often desirable to prevent the initiation of flowers early in the season to obtain vigorous vegetative growth and to avoid the risk of flower loss because of cold stress. This often happens with peppers.

Control of flower development would be an obvious asset to orchard owners in avoiding bloom-killing spring frosts. Apple-tree flowering needs to be encouraged or discouraged, depending on tree age and

Une approche récente, basée sur les cultures en tubes d'essais, aide à déterminer la nature chimique du stimulus de floraison. Durant 50 ans, les scientifiques ont effectué diverses tentatives, sans succès toutefois, d'isoler les éléments chimiques provoquant la floraison. Si ces substances de première importance pouvaient être identifiées et purifiées, elles pourraient être utilisées pour développer et accélérer les cultures.

tree spacing. Chemicals that suppress flower development or encourage flower initiation would be of considerable benefit in orchard management. Apart from the advantages of being able to control the timing and rate of flowering, the discovery of flower-inducing chemicals could also increase the numbers of flowers produced, resulting in higher yields of important crops.

For almost 50 years scientists have tried, without success, to isolate and characterize the elusive flowering stimulus. This stimulus is thought to be a group of flower-producing biochemicals which are produced in the leaves and are then transported to the growing tip of stems where they divert growth activities away from producing leaves into the production of flower buds. Because the nature of these substances is unknown, only hit-or-miss extraction procedures can be used. Further information about the production and action of the flowering stimulus may lead to the development of more successful extraction procedures.

Research efforts have been hampered because of the lack of a suitable bioassay system on which to monitor plant extracts for the presence of flower-inducing chemicals. The bioassay, or plant system used for testing for a particular activity, employed to demonstrate the activity of flowering substances in extracts should be one which does not itself produce such substances (since these would mask any effect of the extracts being tested). A better understanding of the induction and activity of flower-inducing substances and the development of suitable bioassay systems are essential steps for further progress.

One novel approach, based on the test-tube principles of plant-cell culture, is being attempted at Agriculture Canada's Ottawa Research Station. It involves the use of leaf segments of *Streptocarpus nobilis* this plant, a close relative of the Cape Primrose, does not produce flowers when grown during long days (16 h exposure to light); but when exposed to short days (8 h), flower-inducing chemicals are formed and flowering results (Table 1). When small segments of leaves are taken from vegetative plants and grown in test tubes containing a complex chemical mixture, flower buds are formed on short days (Figure 1). When the leaf segments are grown during long days no flowers are formed (Table 2). By comparing the metabolism of the chemicals in leaves maintained in either 8-h or 16-h days, we hope to obtain information which will indicate the type of chemicals needed to produce flower buds.

Figure 1. Development of flower primordia on leaf explants of Streptocarpus nobilis.

Leaf segments from the Streptocarpus nobilis *are used in plant cell culture.*

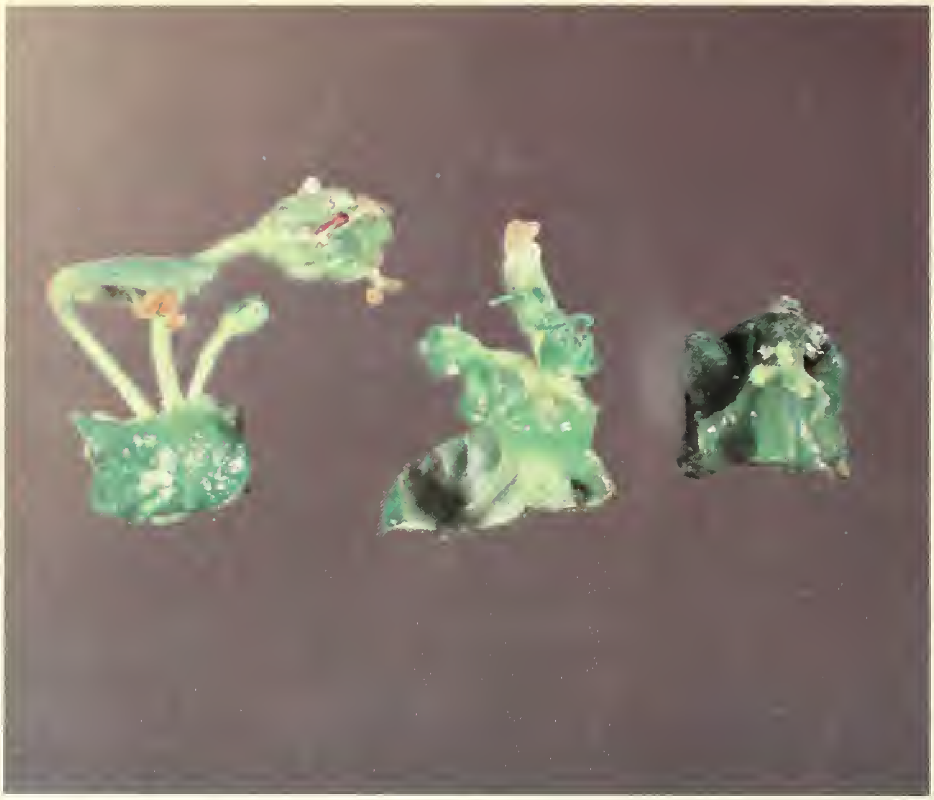


Figure 2. *'In vitro' development of flowers on the basal region of the main vein of* Streptocarpus nobilis *leaf explants.*

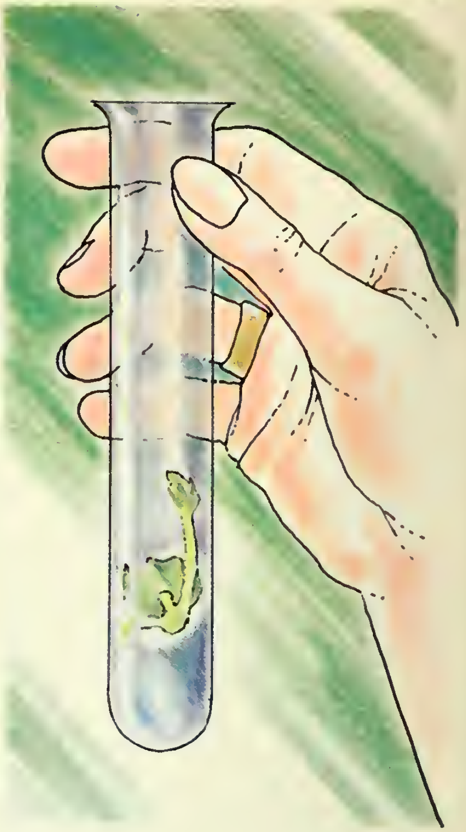


Table 1. Photoperiod control of flowering in *Streptocarpus nobilis*

Number of short days[a] (6-h photoperiod, 25°C)	Percentage flowering	Degree of flowering	First floral node
1	100	+	6 & 7
3	100	+	6
7	100	+ +	5
10	100	+ + +	2
14	100	+ + + +	1
Long-day control	0	—	—

[a] Five node plants received short-day treatments and were then transferred to 16-h photoperiods.

Table 2. 'In vitro' induction of flowering of *Streptocarpus nobilis*[a]

8-h photoperiod			16-h photoperiod		
Percent explants with flower buds	Flower buds per responding explant	Flower buds per 100 explants	Percent explants with flower buds	Flower buds per responding explant	Flower buds per 100 explants
26	2.33	61	0	0	0

[a] Leaf explants were taken from vegetative plants and cultured during either long days or short days.

Table 3. 'In vitro' expression of floral stimulus in non-inductive photoperiods[a]

8-h explant photoperiod			16-h explant photoperiod		
Percent explants with flower buds	Flower buds per responding explant	Flower buds per 100 explant	Percent explants with flower buds	Flower buds per responding explant	Flower buds per 100 explants
95	4.72	448	65	2.38	154

[a] Leaf explants were taken from photoperiodically induced leaves of *Streptocarpus nobilis* and cultured on either long days or short days.

Leaf segments taken from plants grown on short days will produce flower buds when cultured in test tubes maintained during long days (Table 3). Thus the flower-inducing chemicals formed on short days remain stable within the leaf tissue for some time and can be expressed in tissue maintained in conditions which prevent the synthesis of flowering substances. A further important feature of this system is that it provides a suitable bioassay for testing the flower-promoting activity of plant extracts — an essential step in our attempts to isolate and characterize flower-inducing substances.

Hundreds of leaf sections are being grown in test tubes at the research station in an attempt to determine the chemical nature of the flowering stimulus. Chemicals that can influence the action of the stimulus are being used to probe the nature of the stimulus so that extraction procedures may be modified. Ultimately we hope that such extracts can be tested on leaf explants and flower-inducing activity demonstrated. We shall then be in a position to identify and purify these important substances.

Dr. John Simmonds is a floriculture specialist at the Agriculture Canada Research Station, Ottawa.

Disease control and embryo transfer

E.L. Singh

The prevention or elimination of viral diseases in domestic animals can be difficult. Methods include vaccination, control or eradication of insect vectors, slaughter of infected animals, importation of animals from disease-free areas, and quarantine of imported animals. However, these methods, even when successful, can have serious drawbacks. The slaughter of infected animals may eliminate disease, but it can also result in the loss of a lifetime of genetic planning for purebred breeders.

In addition, the ever-increasing demand for more efficient animal production requires maximum utilization of available genetic material to improve breeding stock. This involves the exchange of germ plasm in the form of animals, semen, or embryos throughout the world. However, this need for genetic material has often been overshadowed by importing countries' concern over introducing exotic (foreign) viruses.

La demande croissante d'une meilleure production animale a stimulé les échanges internationaux de sujets reproducteurs, spermes et d'embryons. Le danger de propagation de maladies pouvant en résulter a entraîné de nombreuses restrictions en matière d'importations et d'exportations, ce qui influe sur les échanges et limite les possibilités de développement.

L'importation et l'utilisation de spermes permettant de réduire considérablement les dangers de transmission des maladies. Quant aux embryons, ils représentent théoriquement moins de danger encore. Les instituts de recherches zootechniques d'Agriculture Canada à Ottawa et Lethbridge étudient actuellement les possibilités de transfert d'embryons comme moyen de lutte contre la transmission des maladies.

The importation and use of semen minimizes some of the dangers of disease transmission as semen is less likely to transmit infectious organisms than the animals themselves. Bulls in artificial insemination (A.I.) centers are maintained as relatively stable populations, receive good veterinary care, and are regularly tested for transmissible diseases. Animals for import and export, on the other hand, come from various premises and have contact with other animals. They are examined, tested repeatedly, and quarantined for months in an effort to ensure their disease-free status. However, despite these expensive and rigorous procedures, the risk for disease transmission is considerably higher when animals rather than semen are imported.

Unfortunately, the importation and use of semen does not entirely eliminate the risk of disease transmission. Foot and mouth disease, bluetongue, bovine leukemia, infectious bovine rhinotracheitis, bovine viral diarrhea, ephemeral fever, and lumpyskin disease viruses have been isolated from bovine semen. Foot and mouth disease, swine vesicular disease, parvovirus, picornaviruses, adenoviruses, and Japanese encephalitis viruses have been detected in swine semen. Although the presence of most of these viruses in semen is rare, the potential for disease transmission through A.I. must be recognized. For example, infectious bovine rhinotracheitis (IBR) has been introduced into previously uninfected herds and areas where cattle were inseminated with semen contaminated with the virus.

Theoretically, the potential of embryos transmitting disease is considerably less than that of semen or animals. For this reason we are carrying out investigations at Agriculture Canada's Animal Diseases Research Institutes (Nepean and Lethbridge) to determine whether embryo transfer could be used for disease control. The possibility of obtaining uninfected embryos from infected parents or herds is being studied to determine the feasibility of bringing disease-free genetic material into the country from infected areas, as well as allowing breeders to use embryo transfer to eliminate viral diseases from their herds or flocks in one generation without losing the gene pool.

Aerial view of Agriculture Canada's Animal Diseases Research Institute complex, Ottawa.

Viral diseases are transmitted to embryos in one of two ways: (1) the virus is carried in the gametes (unfertilized egg or spermatozoon) so that infection occurs at fertilization, or (2) the developing embryo is infected with virus present in the reproductive tract of its mother. Thus the success of embryo transfer for disease control depends on the virus in question not being transmitted via the gametes and not infecting the embryo before collection for transfer to recipient animals.

There has been limited work regarding the mode of transmission of pre-natal infections in domestic animals. However, few viruses have been implicated in the infection of the gametes. Viruses found in semen are usually present in the seminal fluid rather than in the spermatozoa themselves, and it is indeed likely that most infections found in early embryos originate from their environment and not directly via the gametes.

Embryo transfer involves the transfer of embryos usually at the late morula or early blastocyst stage (Figure I). If gametic infection is ruled out, then embryonic infection can only occur during the few days before the embryos are removed from infected donors and transferred to uninfected recipients. In terms of disease eradication, the stage of development at which embryos are transferred is important. Morula and early blastocyst stage embryos have not 'hatched' and are still within a membrane or envelope known as the zona pellucida (Figure I). In experiments with mouse embryos, the zona pellucida was found to be an effective viral barrier to certain viruses. It was shown that Coxsackie B_3, feline leukemia, Mengo encephalitis, and western equine encephalomyelitis viruses could penetrate the zona pellucida and infect the embryo, while Maloney sarcoma, Maloney leukemia, Newcastle disease, porcine parvovirus, and vesicular

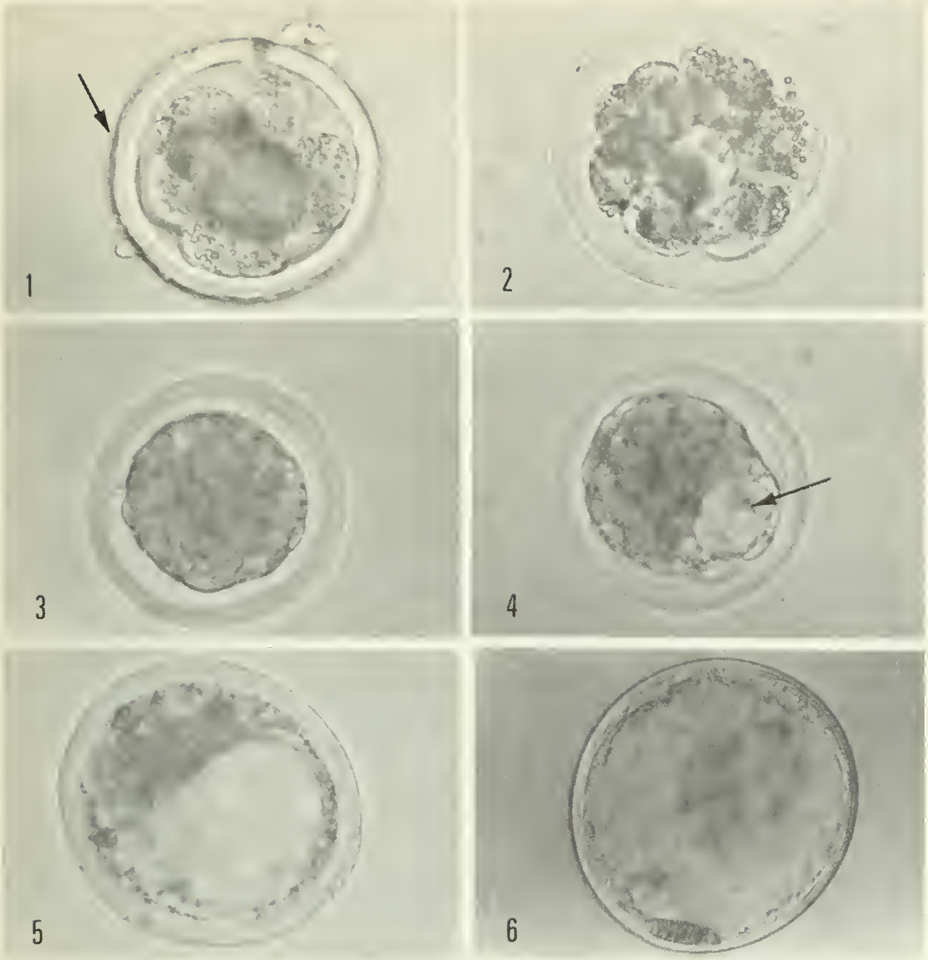


Figure 1. Bovine Embryos.
1) 8-cell stage (day 4), the zona pellucida (arrow) is indicated
2) 16-cell stage (day 5)
3) early morula stage (day 6)
4) blastocoel cavity (arrow) begins to form (day 7)
5) developing blastocyst (day 7-8)
6) blastocyst (day 8-9)

stomatitis viruses were unable to cross this membrane to gain access to the embryonic cells. Since there is no way of predicting whether a virus will be able to penetrate the zona pellucida, each virus must be tested individually.

As an initial step in determining the feasibility of embryo transfer for disease control, experiments are being done to determine whether or not certain viruses can infect the morula and blastocyst stages of bovine and porcine embryos. The viruses under study are bluetongue, akabane, bovine viral diarrhea, infectious bovine rhinotracheitis, porcine parvovirus, swine vesicular disease, African swine fever, and pseudorabies. Embryos are exposed to different infectivity levels for each virus, washed well, and then cultured before being analyzed for infection. The range of infectivity levels for each virus permits the testing of infection levels rarely found in the animal population. In addition, by culturing the embryos after exposure to the virus, any effect of the virus on embryonic development can be detected.

These experiments also allow identification of the infection site; that is, whether the virus is within the embryonic cells themselves or on the zona pellucida. Virus attached to the surface of the zona pellucida when embryos are transferred could be as much of a threat in terms of disease transmission as virus within the embryonic cells. However, if the virus is on the zona pellucida, the possibility exists that it could be removed or inactivated before transferring the embryo to its recipient.

Finally, these experiments allow us to determine whether or not the embryo's age is a factor in infection. It has been demonstrated that mouse embryos at the two-cell stage are resistant to polyoma virus but at the blastocyst stage they become susceptible to viral infection. Thus it is important to determine if any changes occur in the infectivity of bovine and porcine embryos by the viruses under study, since it could affect the developmental stage at which embryos must be removed from infected donors for them to remain uninfected.

The information obtained from these experiments is then applied to further study of the transmission of these viruses by using embryo transfer techniques. Embryos are collected from naturally infected donors or donors that have been innoculated to produce a viremic infection. The embryos from infected animals are then transferred to uninfected recipients which are quarantined throughout their pregnancy to ensure that any infection that develops can be attributed to the embryo and not contact with other animals. Enzootic bovine leukosis, bluetongue, and infectious bovine rhinotracheitis are being tested using embryo transfer. If the calves produced by these experiments remain negative, then gametic as well as early embryonic infection will have been ruled out for transmission of these diseases.

It is hoped that the results from these and similar experiments will lead to the establishment of a list of viral diseases that are not transmitted to early embryos. Importing countries concerned with introducing these viruses could conceivably limit their imports to embryos rather than animals, and restrictions that currently apply to the import and export of embryos might be revised. Both measures would result in considerable savings to the livestock industry and the governments involved. Lastly, a breeder would no longer be faced with the loss of a lifetime of genetic planning if one of these viral diseases became endemic on his farm. Embryo transfer would allow eradication of the disease in one generation without the loss of the gene pool.

Dr. Elizabeth Singh is a scientist with the Animal Diseases Research Institute, Agriculture Canada, Ottawa.

Farm-scale alcohol… fuel for thought

R.D. Hayes

Some exciting opportunities exist in Canada for the production of fuel alcohol on the farm from feedstock fermentation. Any farmer considering establishing a manufacturing plant must understand the production process, end-use opportunities for the fuel, safety precautions, the economics of the process, and how to integrate the production plant into the existing farm system without disrupting normal farm operations. One of the first decisions to be made regards the desired plant size or capacity. This decision largely depends on the amount of fuel alcohol needed, availability of feedstock (e.g., corn, culls, and beets) for raw material, disposal prospects for the by-product, and the capital cost.

The production process itself has many steps — beginning with feedstock preparation to creating a mash for fermentation. Feedstock is crushed or milled (in the case of cereal grains, corn, etc.), chopped (potatoes and Jerusalem artichokes), or squeezed to extract sugar juices (sugar beets, sweet sorghum, and fruits). Starch is converted to sugar in all but sugar crops by adding water and enzyme (barley malt or commercial enzymes), adjusting the acidity level by adding acid or alkali, and

Il existe, au Canada, de vastes possibilités de produire sur les fermes de l'alco-essence. Ce combustible est obtenu à partir de la fermentation d'aliments pour animaux. L'article qui suit traite de l'installation d'un appareillage de production d'alco-essence, de son utilisation, des mesures de sécurité à prendre, des aspects économiques et de son intégration à la ferme.

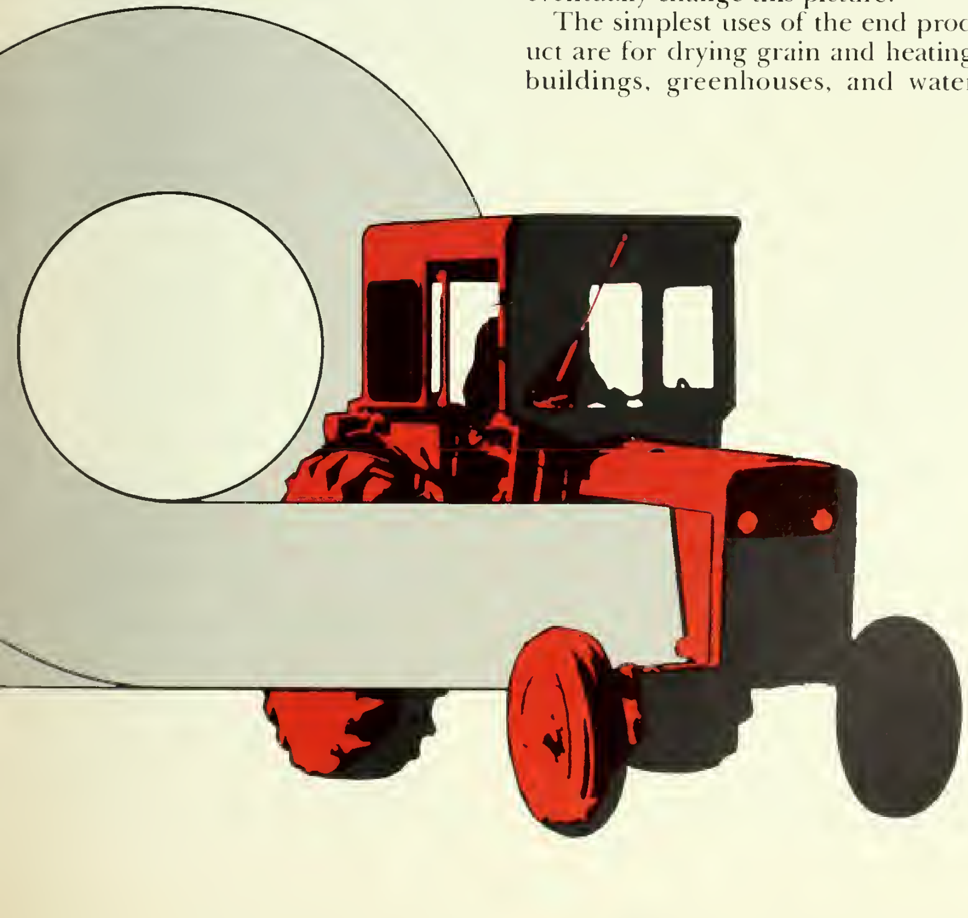
cooking for a specified time. Water is added so that the final concentration of sugar in the mash is about 16 to 22%. Since cooking does not kill all microorganisms that can lower alcohol yield, the mash should be sterilized.

Yeast is introduced to begin fermentation. When pure sugar or starch is used as feedstock, small amounts of such nutrients as urea or ammonium salts are added to assist the yeast. When fermentation is complete (in 2 to 6 days), the fermentation tank will contain a mixture of alcohol and water plus a residue of spent mash. The liquids are distilled to produce alcohol in a 'boiling-off' process that has several levels of technological sophistication. Research is underway to find less energy-intensive ways than distillation to separate alcohol from its watery companions.

Spent mash, or stillage as it is normally called, can be dried to store for

later use, but it is more economical to feed the stillage wet, directly to livestock, possibly removing some water with a centrifuge, screening device, or filter press. (Preservation methods, however, are being researched.) To avoid nutrient loss and spoilage it should be fed to animals within a day or two of production. As a general guideline, cows can consume as much as 45 L of stillage a day, a feeder calf about 30 L, a pig about 20 L, and a chicken less than 2 L. Since stillage has a unique taste, intermittent feeding could cause high-production animals to go off feed. Undesirable flavors in milk may arise when dairy cows are fed stillage before milking.

The major energy inputs in the whole process go into the starch cooking-saccharification and distillation steps as well as the energy inputs used to grow the raw material. One way to conserve energy is to feed stillage wet rather than using energy to dry it for later use. One can also choose a sugar feedstock such as sweet sorghum, sugar beet, or fodder beet that does not require energy-intensive cooking and starch conversion. The future may see less energy-intensive technologies available for starch conversion and alcohol recovery. Research and development is making rapid advances in these areas.



It may make good sense to use 'abundant' and lower-cost energy inputs such as propane, natural gas, or biomass (i.e., wood or crop residues) in the production process rather than more expensive gasoline, diesel, or heating oil. And it is better to buy sophisticated energy-efficient processing equipment. Usable waste heat may be available to preheat process water or provide low-grade heat for vacuum distillation. Farmers should avoid using feedstocks of high food value and feed crops that have incurred large energy inputs. It is better to use crop surpluses (if available), spoiled grains, and culled crops.

Capital costs for plant construction will vary widely depending on sophistication, plant size, the fabrication material, whether the plant is manually operated or automated, and whether the farmer is able to construct some of the components himself. Components of the alcohol plant include the materials handling equipment, fermenters, distillation apparatus, and storage facilities for feedstock, alcohol, and by-product stillage. In most cases the single farm alcohol production unit is unlikely to produce fuel competitive with our low farm-delivered prices for fuel oil, gasoline, and diesel fuel. But research and development and rising energy costs will eventually change this picture.

The simplest uses of the end product are for drying grain and heating buildings, greenhouses, and water. For use in the gasoline or spark-ignition engine there are three possible options. The first is gasohol, a 10% blend of anhydrous (i.e., virtually water-free) alcohol and gasoline. Added alcohol must be close to 100% pure with virtually no water, otherwise the two fuels will not stay mixed. Gasohol used in farm equipment appears attractive because there's no need to modify existing engines. But it may not make economic sense now for the farmer. There are significant additional dollar and energy costs to removing the last 5% of water from alcohol, with a limited reward (only 10% of the farmer's gasoline requirements are filled).

Another future option may be to form an unstable emulsion of gasoline and watery (i.e., hydrated) alcohol prior to carburetion or injection to run farm equipment. The hydrated alcohol might contain anywhere from 5 to 40% water. Several techniques under study at the Ontario Research Foundation are showing promise.

A third option — replacing gasoline with straight hydrated alcohol — is perhaps the only realistic one for the moment. It would involve a slight modification of the carburetor jet to adjust the fuel-air ratio, a crude heat exchanger bringing heat from the exhaust manifold to preheat incoming combustion air (and fuel, if desired), and a very small tank of gasoline to start and run the engine until it warms up.

The use of alcohol in diesel or compression ignition engines presents a problem. Alcohol has an extremely low cetane rating and will not ignite under compression in the diesel engine. The cetane rating can be boosted, however, by adding chemicals such as cyclohexylnitrate, hexylnitrate, and amylnitrate in blends of up to 20%. This is what is done in Brazil to Mercedes-Benz trucks and buses. Unfortunately, these additives are very expensive.

Another possibility is to blend 10% anhydrous alcohol with diesel fuel to form diesohol. This combination has a sufficiently high cetane rating to ignite under compression. But the water tolerance of such a blend is even lower than that for gasohol. Except under carefully controlled conditions where both diesel fuel and the alcohol are kept very dry, this is not a practical option for farmers. Furthermore, the same economic reasons that prevent

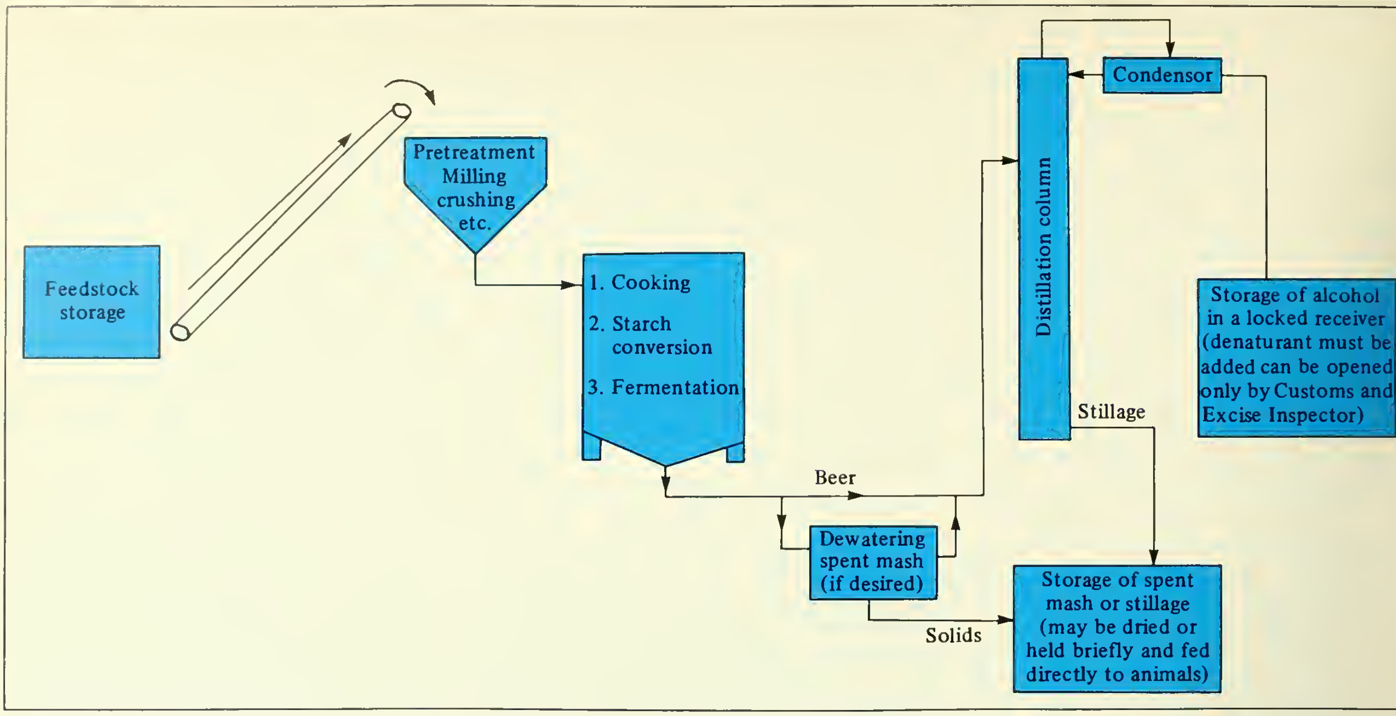


Figure 1. A simple flow diagram of the distillation process.

gasohol from being an attractive option apply equally to diesohol.

The Germans and Swedes have been investigating a dual-injection technique in which alcohol and diesel fuel are injected separately into the engine cylinder. A small amount of diesel fuel is injected as a 'pilot spray' just before the alcohol is injected. The piston's compression stroke ignites the diesel fuel which in turn ignites the injected spray of alcohol.

Perhaps the only diesel option presently available to farmers is conversion to spark ignition. This entails removing the fuel injection system, installing spark plugs, distributor, carburetor, etc., a heat exchanger for preheating combustion air, a small gasoline tank for starting the engine, and decreasing the compression ratio by adding another head gasket. The modification expense is by no means minor, but it does permit the use of straight farm-produced alcohol that contains some water.

Under existing legislation, alcohol produced on the farm must be collected in a 'locked receiver' which can only be opened by a customs and excise inspector. The alcohol must also be denatured (made undrinkable) by adding a prescribed chemical if it is to be exempt from excise duty. A distiller's licence at $250 is required as well as a surety bond for a minimum of $200 000. (This type of bond costs $500 a year.) Changes are anticipated in this legislation to reduce the bonding and licensing requirements for experimental fuel-grade alcohol production.

Anyone intending to experiment with fuel-alcohol production must be fully aware of the health, fire, and explosion hazards. All sources of flame or spark must be eliminated from the vicinity of the distillation apparatus and alcohol storage area. Adequate ventilation of the production premises is also essential.

The farm cooperative approach to fuel-alcohol production seems to be the most economical route to follow. Perhaps 5 to 25 farmers could enter a business arrangement to produce fuel alcohol on a scale of 500 000 L or more a year.

Such larger-scale operations produce certain economies. Moreover, the cost, risk, and benefits are shared among the members. And a group operation can afford to hire a qualified person to run the plant while the farmers concentrate on farming. A group has the economic power to purchase reliable, safe, efficient, and long-lasting equipment. Group members must coordinate the supply and use of feedstock, stillage, and the end-product fuel. Some members will have more feedstock available to supply the plant than others, some a greater need for alcohol fuel, and some more animals which can use the stillage. Financial arrangements between group members might be complicated, but the method is workable.

A cooperative effort of this kind could lead some day to a much more sophisticated group approach which would permit a variety of activities centered on the fuel alcohol plant. For example, a specially grown energy crop could provide feedstock for the alcohol plant. Alcohol fuel could run the field machinery. Stillage and feed crops would be fed to the animals. Manure would provide feedstock for an anaerobic digester, which could produce methane to fuel the alcohol plant. Digester sludge could fertilize the fields and cash crops and animals could be sold for profit. One would then have a completely integrated system.

Readers may also find useful the Agriculture Canada publication *Farm-scale Production and Use of Fuel Alcohol: Opportunities and Problems*. The publication number is 1712 and it can be obtained free from Information Services, Agriculture Canada, Ottawa K1A 0C7. This publication covers in detail fire and other safety hazards associated with farm-fuel production.

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Scrapie control ... Is it worth it?

V. Meere

Animal disease researchers describe scrapie as a fatal, progressive, degenerative disease of the central nervous system of sheep and goats. They know it has existed in Great Britain for more than 200 years and that in North America it was first diagnosed in 1939, in a flock near Oshawa, Ontario. This was one year after sheep had been introduced from Britain into the flock.

What researchers don't know after many years of laboratory and field experimentation is what causes scrapie. The causative agent has not yet been visualized nor is its chemical nature fully understood. Is it some sort of virus, some type of self-replicating cell membrane, or part of a membrane?

Researchers don't know how the disease is transmitted and there is no diagnostic test. Only after death, by examining brain tissue, can it be determined positively that an animal was afflicted.

No link with humans

There is no evidence that the scrapie agent affects humans. Nor is it believed that there is a link between scrapie and similar human diseases such as Kuru, an affliction associated with cannibalism in New Guinea, or Creutzfeldt-Jacob Disease, which strikes only a few people per million in the civilized world. All three are degenerative diseases of the brain and some researchers group them with what are called the spongiform encephalopathies. No causative agent has been found for any of them. There has been success, however, in finding what causes so-called 'slow virus diseases' such as feline leukemia,

Depuis 1945, Agriculture Canada a imposé l'abattage de 18 000 moutons afin de tenter d'éliminer la tremblante, une sorte de maladie fatale pour ces animaux, qui a été détectée pour la première fois au Canada en 1939. Il existe deux écoles de pensée en ce qui concerne l'utilité des programmes destinés à contrôler ou à enrayer cette maladie. La première suggère que si la maladie se répandait, elle pourrait provoquer de sérieuses pertes dans le domaine économique. La seconde considère que la tremblante n'a pas d'importance économique et cite le cas de l'Angleterre où cette maladie sévit depuis deux cents ans sans beaucoup perturber le secteur de la production du mouton.

enzootic bovine leukosis, visna/maedi, distemper encephalitis, and other viruses that play hide-and-seek to escape natural body defences. Sheep-to-human transfer of the scrapie agent is discounted, especially in Iceland, where annual consumption of lamb and mutton is about 90 lb per person. In the last 25 years there have only been two cases of Creutzfeldt-Jacob Disease in Iceland.

One of the surest signs that a sheep has an advanced case of scrapie is if it shows incoordination — a halting gait and involuntary head shaking. It is because of this that in France the disease is known as 'la tremblante'. In Iceland it's called Rida, which means tremor. An afflicted animal acts much like a drunkard. It may stagger and run into other animals and fences. It may drool. The disease causes wool loss when the animal rubs itching skin against fixed objects. Its appetite may be normal but there is weight loss because the animal can't chew or swallow properly. Because of the slow-acting nature of the disease, these signs don't show up until just months before death. Death comes usually 3 to 5 months after the appearance of symptoms. Some animals have been known to take 14 months to die.

Scrapie's long incubation period makes it difficult to apply a control or eradication program. It may not show up in sheep until 3, 4, or 5 years after exposure. During that time a breeding ewe could have been sold to another farm — and infected that flock without the owner's knowledge until it was too late. Scrapie transmission occurs from animal to animal by direct contact, or from parent to progeny before birth. Most are apparently infected at birth and will develop symptoms from 36 to 48 months of age. American researchers have found that even scrapie-free sires and scrapie-free dams will produce scrapied lambs if put amid a scrapied flock. The incidence of cases in infected flocks appears to remain relatively low in North America. On the other hand, in a heavily infected environment or flock, 20 to 40 percent of the animals can develop scrapie.

Eradication programs have not eliminated scrapie in Canada's sheep population of 725 000. And similar programs have not worked in Iceland and the United States. Since 1945, when scrapie was made a reportable disease in Canada, the department of agriculture has ordered destruction of some 18 000 sheep.

Iceland, with about 900 000 sheep today, has slaughtered 650 000 since 1944 without wiping out the disease. Only in New Zealand and Australia has scrapie not reoccurred after slaughtering programs in the 1950s.

Agriculture Canada officials have found it difficult to justify continuation of the scrapie program. There is no evidence that scrapie causes economic loss in Canadian sheep flocks because of a production loss. It would appear that the sole reason for having a scrapie program is to protect a very small export market, and, if cost-benefit analysis is performed, the benefit-cost ratio would be very low. During the fiscal year 1980-81, compensation paid by Agriculture Canada for the destruction of scrapie-infected herds was equal to the value ($600 000) of the exported breeding animals.

Findings from Iceland

Iceland's attempt to eradicate the disease — discussed in February at an Agriculture Canada scrapie consultative meeting by Iceland's chief veterinary officer Dr. P.A. Palsson — illustrates its complex and perplexing nature, and the frustration it breeds among producers and animal disease-control officers. Dr. Palsson made the following observations:

— Sheep farmers in Iceland have always considered scrapie an infectious disease. The oral route of infection has been considered the most

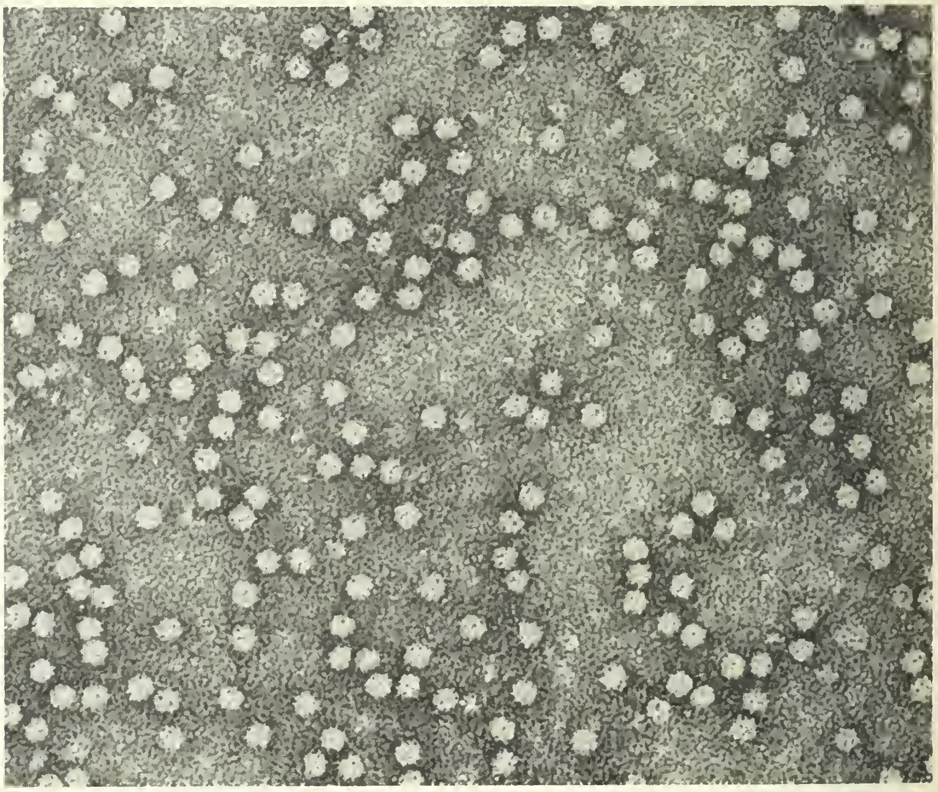

Figure 1. Virus-like particles, taken from a scrapie-infected brain of a mouse, are magnified 250 000 times by an electron microscope at Agriculture Canada's Animal Research Institute, Ottawa.

likely, probably from feed and drinking water contaminated by affected flockmates.

— Certain bloodlines within a flock seem to be more susceptible and develop signs at a younger age. (Canadian research in the early 1960s and recent American findings also suggest that heredity is a factor.)

— When the disease is first introduced into a flock, only a few sheep are affected during the first 2 to 4 years. Then more and more cases are usually observed each year. In moderately affected flocks, a mortality rate among breeding ewes of 3 to 5 percent annually is common for a few years. Within some flocks, however, a mortality rate among adults of more than 30 percent a year has been found. Because of such heavy losses, several flocks have been destroyed in recent years.

— From the time scrapie was introduced in 1878, in a ram imported from Denmark, the disease has been endemic in parts of Iceland's north. Until the late 1930s, sheep from the north were sold freely to other districts. Yet the disease does not seem to have spread to other parts of the country.

— In the late 1930s the country was divided by fences into quarantine areas to prevent the spread of another disease — maedi — a devastating respiratory disease of sheep. All sheep movement from the scrapie endemic area was thus ended as well. From 1944 to 1954 a systematic eradication program for maedi was carried out. As part of this program, all sheep in the scrapie endemic area were destroyed between 1945 to 1947. In some areas all farms were left without sheep for 3 years before being restocked with healthy lambs. Maedi was eradicated but scrapie appeared 2 to 4 years later on some of those farms.

— Now the disease is again widespread in the original endemic region, having spread from the few farms where it appeared after eradication. It is not known whether there are reservoirs for the infection of animals such as wild field mice, rats, deer, and other rodents; or whether the soil, feed, buildings, or fences can remain infected for long periods.

— Owners of some farms where scrapie has caused exceptionally heavy losses have in recent years killed all their sheep and cleaned and disinfected the buildings where sheep had been kept. The farms have been left free of sheep for 2 to 12 months before being restocked with sheep from flocks where scrapie had been unknown. Again, most attempts to rid the farms of the disease failed, with scrapie reappearing in the new flock 2 to 4 years later. Hence it seems that the disease agent survived the disinfection.

— In recent years, scrapie has unexpectedly been discovered in a limited number of flocks far apart and far from the endemic area. No contact with affected sheep seems to have been possible because of severe restriction on sheep movement within the country. And since Iceland imports no live sheep or sheep products, infection from that source can be excluded.

An appraisal

The Canadian and American scrapie programs are nearly identical and require the destruction of entire infected flocks (the flock in which a scrapied animal has passed part of its life) and source flocks (a flock in which a scrapied animal was born), as well as the destruction of animals which were exposed to the scrapied animal, and various relatives of the scrapied animal. Despite the control programs in both countries for more than 30 years as well as a decreasing sheep population, the rate of scrapie diagnosis has remained at about the same level. Over the years the U.S. government has dispensed approximately $4.6 million in compensation to protect a sheep population of 12 million, whereas in Canada the taxpayer has spent nearly $2 million in the same period to protect a sheep population of less than 1 million.

In Iceland there is no attempt to eradicate the disease. A program is employed to assist farmers in areas where losses from scrapie are heavy and to help prevent its spread. Flocks in endemic areas which suffer a high mortality rate (10 to 20 percent) and newly infected flocks that are detected in areas where the disease was previously unknown are ordered slaughtered, and compensation is paid for the value of the carcasses. With this type of program, Iceland has maintained the rate of diagnosis at a fairly constant level.

While eradication of the disease in Canada appears improbable in the near future, some scrapie experts warn against excessive despair. There has been steady progress in identifying the causative agents of 'slow virus' diseases.

One promising avenue of exploration has been taken by American government researchers. They are doing embryo transplants to see if ewe-to-lamb transmission of the disease occurs or if the active agent is transferred via embryo. They have transplanted embryos from scrapied ewes to clean ewes. They also plan to take clean embryos and place them in infected ewes. It is hoped that this may even produce a disease-free strain of sheep.

Exposure at birth apparently is a key factor. It was discovered that 34 percent of the progeny of 333 previously exposed ewes came down with the disease. It was also found that if lambs were exposed to an infected environment at 3 to 9 months of age, only 3 to 7 percent, depending on the breed, became infected.

Scrapie research at the Animal Diseases Research Institute in Lethbridge and elsewhere has been directed at separating the scrapie agent from mouse brains infected experimentally with the agent. Virus-like particles have been isolated — particles so small that it is even difficult to view them with an electron microscope (Figure 1). This work could eventually lead to an immunological diagnostic test, which would permit the culling of diseased animals from flocks. Without a diagnostic test, those in the regulatory veterinary medicine corps have likened their job to the cavalry rushing to the rescue with no sword — let alone a horse.

Mr. Vil Meere is feature writer for *Canada Agriculture*.

UPDATE / MISE À JOUR

Influence du temps de la répression du chiendent avec le glyphosate sur la productivité de l'orge

R. Rioux

Les applications foliaires de glyphosate avant le travail du sol à l'automne ou au printemps sont efficaces pour réduire l'interférence du chiendent dans les céréales. L'efficacité des applications d'automne est limitée par les récoltes tardives qui ne permettent pas une repousse suffisante du chiendent avant le traitement. Le principal problème des applications au printemps provient du fait que le chiendent doit avoir atteint le stade de trois ou quatre feuilles avant d'être traité au glyphosate, ce qui retarde le semis des céréales au delà du temps optimum. A La Pocatière (Québec), le chiendent atteint le stade trois ou quatre feuilles, au printemps vers le premier juin et à l'automne vers le premier septembre lorsque la fenaison s'est faite à la fin de juin. Ces deux périodes ont été choisies pour mesurer l'influence du temps de l'application du glyphosate sur le rendement de l'orge Champlain.

L'étude poursuivie pendant trois ans montre que les applications d'automne sont plus efficaces contre le chiendent que les applications de printemps (Figure 1). A l'automne l'application de 2,24 kg/ha de glyphosate donne une meilleure répression du chiendent. Au printemps, employer plus de 1,12 kg/ha n'améliorera pas la répression.

Les rendements les plus élevés en ce qui concerne l'orge ont été obtenus avec les traitements d'automne (Figure 2) mais avec une application de 1,68 kg/ha. Au printemps, le rendement optimum est obtenu avec une application de 1,12 kg/ha.

La date de semis plus tardive occasionnée par les traitements de printemps peut aussi avoir contribué à réduire la productivité. Les semis à la suite des traitements d'automne ont été faits en moyenne le 12 mai tandis que ceux à la suite des traitements de printemps ont été faits en moyenne le 10 juin. L'étude montre aussi qu'avec les semis tardifs, le chiendent exerce plus d'interférence sur l'orge.

La relation entre le rendement de l'orge et les pousses de chiendent peut être exprimée par une droite (Figure 3). Une augmentation de la biomasse du chiendent de 10 g/m² provoque une perte moyenne de rendement de 7,5 g/m² dans les semis de mai et de 30,3 g/m² dans ceux de juin. On peut exprimer le degré de interférence au moyen d'un indice formé par la relation $\frac{b}{a}$. Cet indice est plus élevé avec les semis tardifs (0,0022).

L'usage du glyphosate à l'automne donne une répression plus élevée du chiendent qu'un usage au printemps. La date de semis peut aussi être plus hâtive. Ces deux facteurs assurant un meilleur contrôle du chiendent donneront aussi des rendements plus élevés.

M. R. Rioux travaille à la ferme expérimentale d'Agriculture Canada de La Pocatière (Québec).

Quackgrass control with glyphosate is more easily obtained when the weed is at the 3-4 leaf stage. In barley, fall application of glyphosate is more effective than spring application. Barley yields are higher from fall application because it permits earlier spring seeding, resulting in reduced quackgrass competition. Glyphosate used in early fall gives more effective quackgrass control as a result of a better synchronization between stage of growth and time of application.

Spécimen du chiendent tiré de "Budd's Flora" des provinces des Prairies canadiennes.

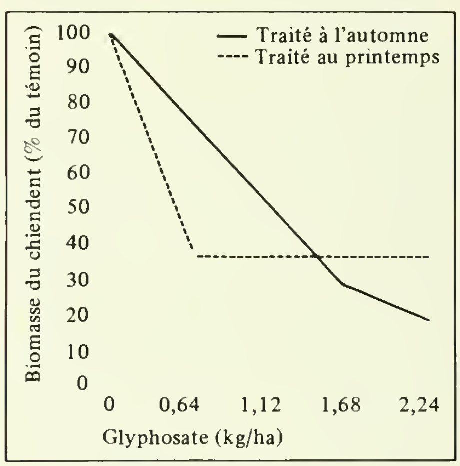

Figure 1. Effet des taux de glyphosate appliqués à l'automne ou au printemps sur la biomasse du chiendent dans l'orge.

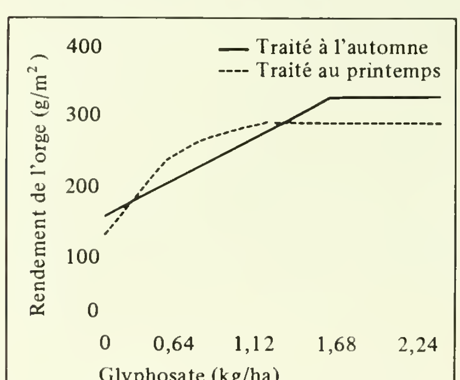

Figure 2. Effet des taux de glyphosate appliqués à l'automne et au printemps sur le rendement de l'orge.

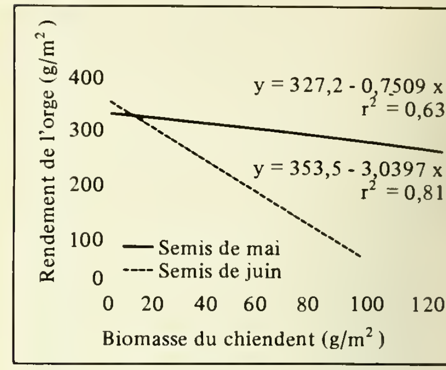

Figure 3. Relation entre la biomasse du chiendent et le rendement de l'orge selon la date de semis.

Farm women

L. Williamson

Women on Canadian farms are showing a new activism to achieve a more equal economic and legal status with men, and a stronger place in the social power structure. Governments and other organizations are taking notice of the more militant stance of some farm women and are helping to finance the revolution in attitudes that could affect the lives of the 477 000 females of all ages on Canada's 338 500 farms.

The budding militancy of some farm women — until now one of the most docile of female groups — was evident at the First National Women's Conference in December 1980. It was largely organized by Dianne Harkin, wife of an Ottawa area cattle farmer and public servant, and the group she heads, Women for the Survival of Agriculture. The conference was notable not so much for what transpired at its sessions, but for the attention and support it attracted.

Three federal departments (Secretary of State, Agriculture, and Finance) contributed funds or personnel to the organization of the conference and all provincial governments except one (British Columbia) paid the travelling expenses of the 10 delegates from each province. Further monetary and other support came from agricultural and rural women's organizations and agribusiness. The impression left was that many organizations are taking farm women seriously in their demands for the rights they feel are their due.

The activist women want recognition for the role farm women play on and off the farm. They are pleased to see that the federal government has moved to remedy what they see as discrimination in the income tax field.

Les dames fermières du Canada se montrent de plus en plus actives pour arriver à obtenir l'égalité avec les hommes ainsi qu'une position plus forte dans la structure sociale. Trois ministères fédéraux (Secrétariat d'Etat, Agriculture et Finances) ont contribué à la première Conférence nationale sur les femmes en décembre 1980. Les résultats obtenus lors de cette assemblée ainsi que des commentaires sur l'augmentation de l'engagement des femmes dans les postes de décisions sont décrits dans l'article qui suit.

The proposed change would permit the farmer-husband to use wages paid to his wife as an income tax deduction in the same manner as wages paid to sons and daughters. One effect is to encourage male farmers to pay their wives in cash for their work on the farm.

Women for the Survival of Agriculture have a checklist of other demands. These include the right of farm wives to participate in various programs — the Canada Pension Plan, unemployment insurance, paid vacations, sick leave, and workmen's compensation. They want equal access with men to credit from lending institutions. They want legal recognition of the contributions of farm wives to the family farm when it comes time to divide the spoils through divorce or for other reasons. Off the farm, they seek places on the policy-forming levels of farm organizations and federal and provincial agencies, boards, commissions, councils, committees, and crown corporations.

On the last point, as of March 1980, women held 15 percent of the appointments to the almost 160 federal agencies on which they are eligible to serve. Of a total of 1248 appointments filled, only 189 went to women. In the United States, women hold 33 percent of available appointments.

In agriculture-related agencies, of a possible 33 appointments, women held only three (9 percent). That number was increased to four on the eve of the December conference, when Agriculture Minister Eugene Whelan appointed Carol Teichrob, a Saskatchewan turkey producer, to the board of the Farm Credit Corporation.

The legal devices of partnership and incorporation to ensure equitable division of farm assets have always been available for knowledgeable women with cooperative husbands. But many farm women have long been unaware of their socio-economic vulnerability and the need to take steps for self-protection. Research has shown that the typical farm woman has traditionally used her spare time for social and community programs. The public and private agencies to which she belonged emphasized the traditional homemaking and motherhood activities of the farm wife, despite evidence that the farm wife works an average of about 29 hours a week in the field or the barn or at farm bookkeeping chores.

The Women's Institute (WI), for instance, has been for more than 50 years the farm wife's 'window to the world'. The militants are virtually unanimous in their belief that the window was narrow and the view restricted. It was a view, perhaps, that accepted such status quo situations as job training and farm management courses offered in central urban locations, too far away and too time-consuming for farm women with small children and daily chores.

Many recognize that farm wives themselves have perpetuated the inferior concept of women that dominated the legal system, government, financial institutions, and public and private social service agencies. They left attendance at farm organizations to their husbands, and the idea of women standing for office in these groups was unheard of.

But it appears that the day is passing when a woman like Dianne Harkin would find herself the only female among 300 attending a farm meeting. This experience at her first rural gathering motivated Mrs. Harkin to form Women for the Survival of Agriculture. Conceived as an 'eventually self-destructing' organization, its purpose is to encourage more farm women to become active in farm organizations and assume more active roles within their farm communities.

It was International Women's Year in 1975 that inspired Mrs. Harkin to start the organization. Begun with a $1960 grant from the Secretary of State, the movement has grown to include about 400 women across Canada, representing all sizes and types of farm. Lately, more women have been turning out to farm organization meetings and taking part in their deliberations. A feeling is growing among the female farm population that urban women are in many cases putting their energy into the trivialities of the feminist cause, while the farm women have serious injustices that need redress. Even among the majority of farm women who take no part in organizations an awakening is taking place, as they read of the activities of others and the results of court cases involving women seeking compensation for farm work at the time of marriage dissolution.

The raised consciousness of farm women is not confined to Canada. The United States has held its fifth national farm women's conference

and Australia its first in 1980. Regional farm women's conferences, like the one that the New Brunswick agriculture department sponsored in 1980, are in the works.

There is other evidence that the male domination in agriculture-related fields is ending. In 1969 only 2 percent of University of Guelph graduates in agriculture were women. Now, about one-third of the graduating classes are women. Women agricultural representatives, record of production inspectors, and veterinarians are now fully accepted by the farming community.

On March 11, the Hon. Lloyd Axworthy, Minister Responsible for the Status of Women, appointed Mrs. Harkin to the Canadian Advisory Council on the Status of Women.

Lenny Williamson is an information officer with Agriculture Canada.

Increasing the selenium content of feedstuffs

K.A. Winter and U.C. Gupta

During the last decade there have been major changes in the status of the trace element selenium (Se). Once known mainly for its toxic effects on cattle, Se is now recognized as an essential trace element for all farm livestock. Researchers have determined that 0.1 ppm Se in the diet is usually sufficient to prevent most Se deficiency problems.

Se supplementation is now permitted for most classes of farm livestock in Canada. Producing feedstuffs containing 0.1 ppm or more to meet the animals' requirements seems to be the preferred supplementation method. When adequate Se is present in a feedstuff such as forage, a uniform daily intake of Se is assured. When an Se enriched salt or mineral mix is fed, it is consumed in variable amounts by individual animals. Hence, some animals may not obtain enough Se to meet their needs while others may consume an excess. Reports indicate that the addition of 0.1 ppm inorganic Se to low Se diets does not protect some animals from Se deficiency problems. Therefore, the production of feedstuffs containing enough Se may be good insurance for some classes of livestock under certain conditions.

A survey of forages in the Atlantic Provinces indicated a general Se deficiency in the region. Several experiments have been conducted to study methods of increasing the Se content of feedstuffs. In the first experiment, Se, in the form of sodium selenite, was added to the soil at rates of 1.1 and 2.2 kg Se/ha before seeding barley and timothy. Se uptake by these two crops was then determined over several cropping seasons.

Results showed that both barley grain and timothy forage from plots without added Se contained less than 0.05 ppm Se. When 1.1 kg Se/ha was applied, barley contained more than 0.1 ppm Se in the first year, and at the 2.2 kg Se/ha rate the barley contained more than 0.1 ppm Se in the first 2 years. The timothy forage contained more than 0.1 ppm Se for 3 years at the 1.1 kg/ha rate and for 4 years at the 2.2 kg/ha rate. This method showed promise as a technique for increasing the Se content of livestock feed crops. However, where the soil was cultivated annually, as with barley, the Se content of the barley declined more rapidly. In this case more frequent additions of Se would be required than for permanent grass.

L'oligo-élément Selenium (Se), autrefois reconnu pour ses effets toxiques sur les bovins, constitue maintenant un élément essentiel pour tout le bétail de la ferme. Il est maintenant permis d'ajouter des additifs de Se à la diète de la plupart des animaux de la ferme et la meilleure façon d'exercer un contrôle des doses consiste à l'insérer dans l'alimentation lors de la période de croissance. Une étude sur l'alimentation du bétail dans les provinces maritimes a révélé que dans cette région le niveau de Se était très bas dans l'alimentation. D'autres expériences ont démontré l'avantage d'ajouter du Se aux pâturages et aux terres cultivées afin d'obtenir le niveau de Se requis dans les aliments des animaux.

In a second experiment an alternate method for applying Se was used to avoid tillage operations. Sodium selenite in solution was applied at two rates, 0.56 and 1.12 kg Se/ha, to an established grass sward just as spring growth was commencing. Results from 2 years of this experiment indicate that this method was also successful in providing adequate Se levels in the forage. At the application level, 0.56 kg Se/ha, the forage Se content declined to 0.1 ppm Se in the second year, while at the 1.12 kg Se/ha rate the forage was well above 0.1 ppm Se in the second year, in both first and second cut forage. In the two experiments no toxic levels of Se (5 ppm Se or more) were produced in either barley or forage.

Based on these results, it is possible to recommend Se amendment levels which will provide adequate Se in feedstuffs to meet farm livestock requirements. In the case of annual crops the Se can be added to the soil at seeding time. For forages, Se application at seeding can increase the Se content of harvested forage to acceptable levels for 3 to 4 years. Direct Se application to a dormant sward also appears possible. This method can increase the Se content of forage from established stands without the expense of tillage operations.

Dr. K.A. Winter and Dr. U.C. Gupta are research scientists at the Agriculture Canada Research Station, Charlottetown.

Effect of electrical stimulation upon the palatability, consumer acceptance, retail acceptability, and case-life of beef

L.E. Jeremiah and A.H. Martin

Various reports have suggested that the electrical stimulation of beef carcasses prior to chilling significantly enhanced palatability, improved muscle color and uniformity, enhanced retail acceptability, and lengthened retail case-life. However, these reports have not been fully substantiated, since numerous other workers have not consistently observed such advantages. Moreover, few of these reports have indicated that these advantages were present after 6 days of postmortem storage, when most retailers and consumers in North America receive their beef.

Recent research at Agriculture Canada's Lacombe Research Station has failed to reveal significant differences in palatability traits between cuts from stimulated and unstimulated carcasses after 6 days of postmortem storage, when measured with laboratory and consumer panels (Figure 1). Nonsignificant differences were also observed between treated and control sides in the retail acceptability of boneless rib steaks after 6 days of postmortem (Figure 2). In addition, nonsignificant differences in retail case-life were also observed between cuts from treated and control sides (Figure 2). Therefore, electrical stimulation may be of little value for enchancing palatability and retail or consumer acceptance, or extending the retail case-life of beef, when it takes 6 days or more to reach the retailer and the consumer.

Figure 1. Palatability of electrically stimulated and unstimulated beef of different sexes as determined by laboratory and consumer panels.

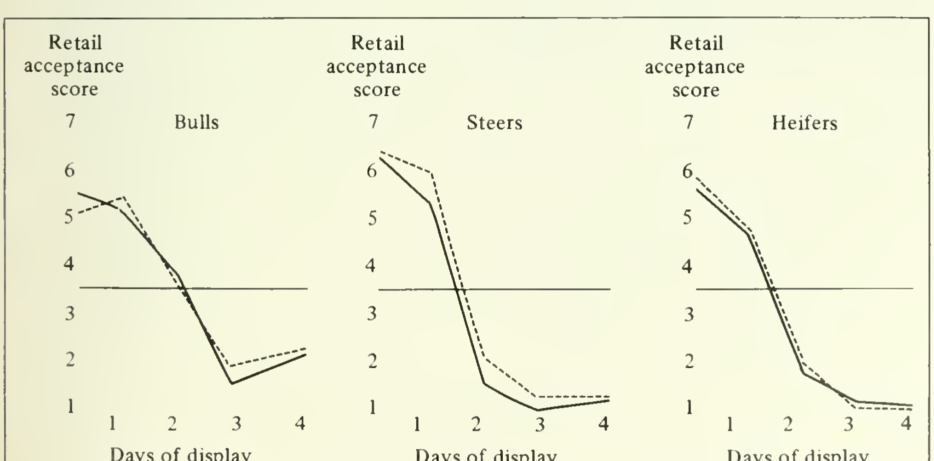

Figure 2. Retail acceptability of electrically stimulated and unstimulated beef of different sexes during 4 days of retail display.

À la station de recherche d'Agriculture Canada de Lacombe (Alberta), des études ont été entreprises pour déterminer si les stimulations électriques des carcasses de boeufs avant la réfrigération pouvaient améliorer le goût de la viande, la couleur des muscles et donc faciliter la vente au détail. Après six jours de conservation on a constaté fort peu de différence entre les carcasses ainsi stimulées et celles qui n'avaient pas été soumises à ce traitement.

It is quite possible, however, that electrical stimulation may produce more rapid development of color and firmness. The technique may be useful for accelerating the chilling process to reduce microbial loads and facilitating more rapid grading, carcass shipping, and hot boning, leading to economies in processing and handling and the prevention of spoilage. It is also possible that electrical stimulation may improve tenderness per se, particularly early in the postmortem period. Hence, the technique may also be useful in accelerating the aging process to provide an acceptable product with less refrigerated storage.

Additional research to document the existence of such potential benefits is underway at the Lacombe station.

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The alfalfa weevil today

D.G. Harcourt

For more than a decade the eastern strain of the alfalfa weevil, *Hypera postica*, has been the dominant alfalfa pest in the lower Great Lakes Region of Canada. Of Eurasian origin, it reached Ontario during the late 1960s as the extension of a population buildup that began in the mid-Atlantic states after its accidental introduction some 15 years earlier. Following its spread through Ontario, its numbers increased at an alarming rate. Damage reached its peak in 1974 when the combination of unusual spring temperatures and record weevil populations resulted in a multi-million dollar loss of alfalfa protein. Farmers in the dairy-intensive Bay of Quinte area and in parts of western Ontario were hardest hit. The attack came just at the time when the prices of protein concentrates were beginning to skyrocket and dairymen were being encouraged to avoid supplemental feeding by producing high quality forage at home.

Fortunately, help arrived from an unexpected source. In June 1973 the weevil population growth in the Quinte area was abruptly halted by the dramatic appearance of a highly contagious disease that attacked and killed the larvae and cocoons (Photo 1). The disease was caused by a complex of two fungi, both of which were new to the insect in North America. The disease spread rapidly and by late 1974 it could be found throughout Ontario. By 1975, weevil populations were declining and during the past 5 years pests have been constrained at a density level which fluctuates about the economic damage threshold of 150 larvae per sq ft (Figure 1). As a result, outbreaks have been restricted. However, scattered epicenters of infestation still exist and growers must constantly be alert for sudden population flare-ups.

La multiplication des charançons de la luzerne continue de gêner les fermes laitières de la région des grands lacs inférieurs de l'Ontario. La situation pourrait cependant s'améliorer car les charançons sont combattus par leurs ennemis naturels et plusieurs stratégies exigeant l'utilisation d'un minimum de produits chimiques ont été développées.

Life cycle and damage

In Ontario the weevil has one generation a year (Figure 2). The adults emerge from hibernation during the last half of April and begin to lay their eggs, first in the ground litter and then on the new alfalfa stems as they begin to grow. Peak egg-laying occurs at the middle of May when the crop is 10 in. tall.

In depositing her eggs the female chews a small hole in the stem which she later caps with macerated plant tissue. These punctures are visible to the naked eye and provide meaningful clues to the level of oviposition activity. Hatching occurs at the end of May and the larvae feed intensively for 2 to 3 weeks before pupating in the foliage or ground litter.

Photo 1. Larva of the alfalfa weevil killed by fungus disease.

The adults emerge in early July, feed for a short period in the alfalfa regrowth, and then disperse from the fields. They aestivate until September when they mate and lay a few eggs which do not survive in cold weather. In late October they migrate from the fields and seek protective sites for winter diapause.

The larvae cause most of the damage. The younger stages feed in the developing leaf and flower buds. The older larvae attack the leaves, and in heavy infestations they shred the foliage so badly that fields take on a greyish-white or frosted appearance. In Ontario the peak of larval attack tends to coincide with the bud stage of the first crop. This is also the best time to cut the crop for maximum protein yield.

Management of pest populations

Since 1972, studies at the Ottawa Research Station have focused on weevil population dynamics and the construction of ecological life tables. This has enabled us to develop a series of mathematical models incorporating the various factors that cause seasonal and annual changes in the pest population. Based on these data, simulation studies to investigate the effects of alternative management strategies are now under way.

At every opportunity growers are reminded of the delicate population balance that exists between the weevil and its biocontrol agents, and all action decisions stress the minimal use of chemicals as a population suppres-

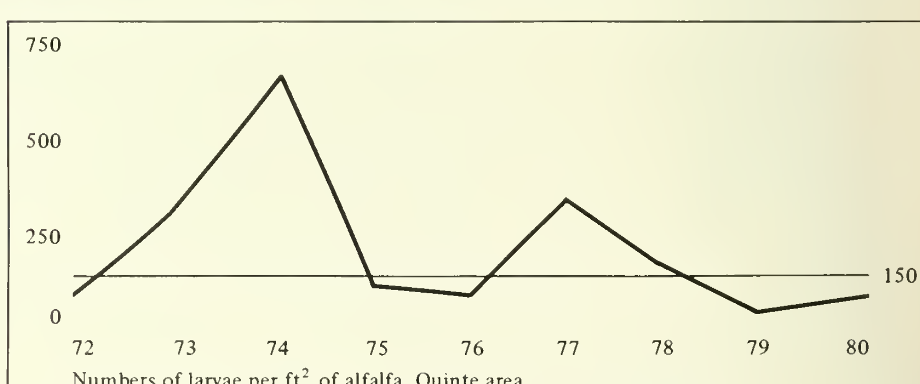

Figure 1. Populations of the alfalfa weevil, 1972-80.

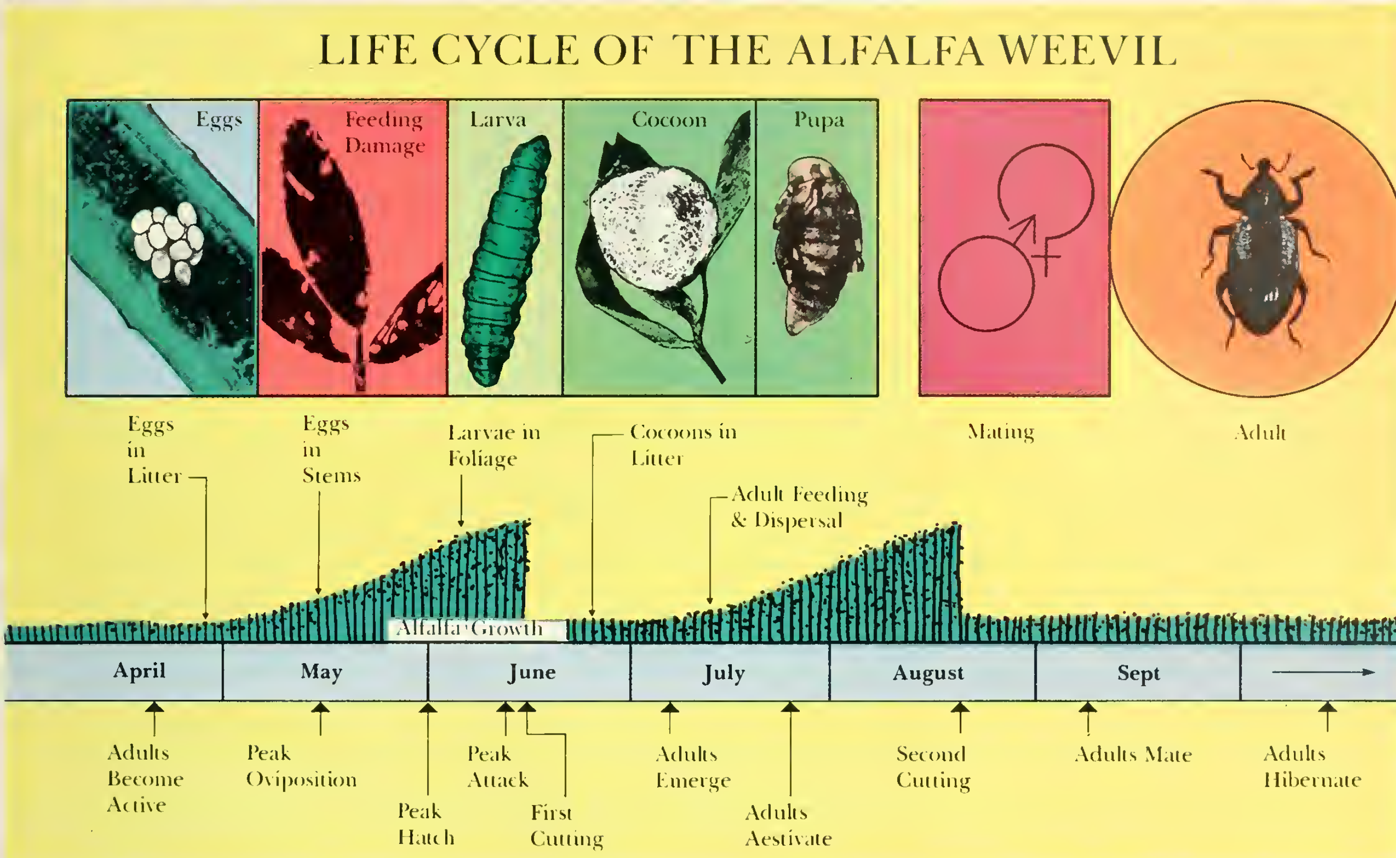

Figure 2. Life cycle of the alfalfa weevil showing average dates of stage activities relative to alfalfa growth in a two-cut system.

sant. Thus in economic situations, early harvest is the recommended control practice since this will kill the younger stages of the insect without disturbing its natural enemies. However, in some years, warm and dry weather in early spring brings the weevil out of hibernation ahead of schedule. This type of weather not only gives the pest a good start, but also slows down the alfalfa so that when the insects are at their worst, the crop is too immature to be cut. In this case, chemical treatment is the only option.

To minimize the danger of unnoticed early attacks, heat unit models have been developed for both the insect and crop, and during the forage season, temperature data are fed online to the Ottawa Research Station from representative areas of Ontario. When used with trend forecasting from the life tables and sequential decision sampling to pinpoint economic pockets of infestation, these data have permitted us to develop an alert system that is tied in to a weekly radio advisory. The advisory is now limited to the Quinte area but we plan to extend it soon to other parts of the province.

Another phase of pest management involves a technique that a dairy farmer can use to make his own treatment decisions. By counting the number of oviposition punctures in a sample of alfalfa stems, quick reference to statistical charts will tell him whether he should prepare to harvest (or spray) his crop right away or whether it is safe to hold back for greater bulk. This method is valuable because it predicts damage before the eggs hatch. In threatening situations this gives the farmer up to 10 days in which to make a treatment decision—and when given sufficient lead time he usually opts for the economy of early cutting. Statistical charts have been developed for all areas of the province.

Ongoing research has shown that by itself the fungus disease is often capable of preventing economic damage. Hence its potential as an applied control alternative is under study. However, the fungus is just the first stage of a three-pronged attack that has been mounted against the weevil. Two parasitic wasps are now making their presence felt in most parts of Ontario. These are *Microctonus colesi* and *M. aethiopoides*, both of which have been recolonized from the United States. The former attacks a significant portion of the larger larvae that escape disease. The latter lays its eggs in the body of the adult weevil and by a peculiar feeding habit the young parasites render their hosts sterile. Native to Europe, both wasps appear to have adapted well to Ontario conditions.

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Microbial formation of acid sulfate soils

K.C. Ivarson and G.J. Ross

In many parts of the world, especially in areas near lakes, rivers, and ocean shorelines, exist soils which are very acid. Their total world area, including a considerable acreage in Canada, is about 40 million acres. These soils have developed on sediments containing pyrite, commonly known as fool's gold, and when first cultivated, farmers generally find that they produce excellent crops. However, as time goes on, sulfuric acid, the same acid that the farmer places in his tractor battery, is produced in the soil and crop yields decrease almost to nothing. Beneath the soil surfaces one finds conspicuous yellow mottles (Figure 1) on basic ferric sulfates having the general formula A $Fe_3(SO_4)_2(OH)_6$ in which A may be potassium, sodium, or hydronium. These basic ferric sulfates will not dissolve in water. A strong solution of muriatic acid is required to dissolve them. If the yellow streaks are dug up and placed in a pile (Figure 2), one discovers that they resemble buried cat manure; thus in some localities they are called cat soils.

At Agriculture Canada's Chemistry and Biology Research Institute the microbiological, chemical, and mineralogical characteristics of these soils have been researched in depth and we have discovered that the responsible creature is a little microbe (Figure 3) measuring 1/25 thousandth of an inch by 1/12 thousandth of an inch. This puny chap exists in the soil, loves lots of air and acid conditions, and thrives solely on a diet of iron and sulfur which it gets from the pyrite. The microbe is called *Thiobacillus ferrooxidans*

Les sols sulfatés acides sont très répandus au Canada et dans le monde. A l'Institut de recherche biologique et chimique d'Agriculture Canada, on a effectué des recherches approfondies sur ces sols pour découvrir que s'ils sont très productifs au départ, leurs qualités s'amoindrissent rapidement à cause de la présence d'un petit microbe dont les habitudes alimentaires transforment le souffre contenu dans le sol en acide. Dans certaines régions, la seule façon de contrôler cette situation a été d'inonder constamment les sols afin de noyer le microbe et de diluer les acides.

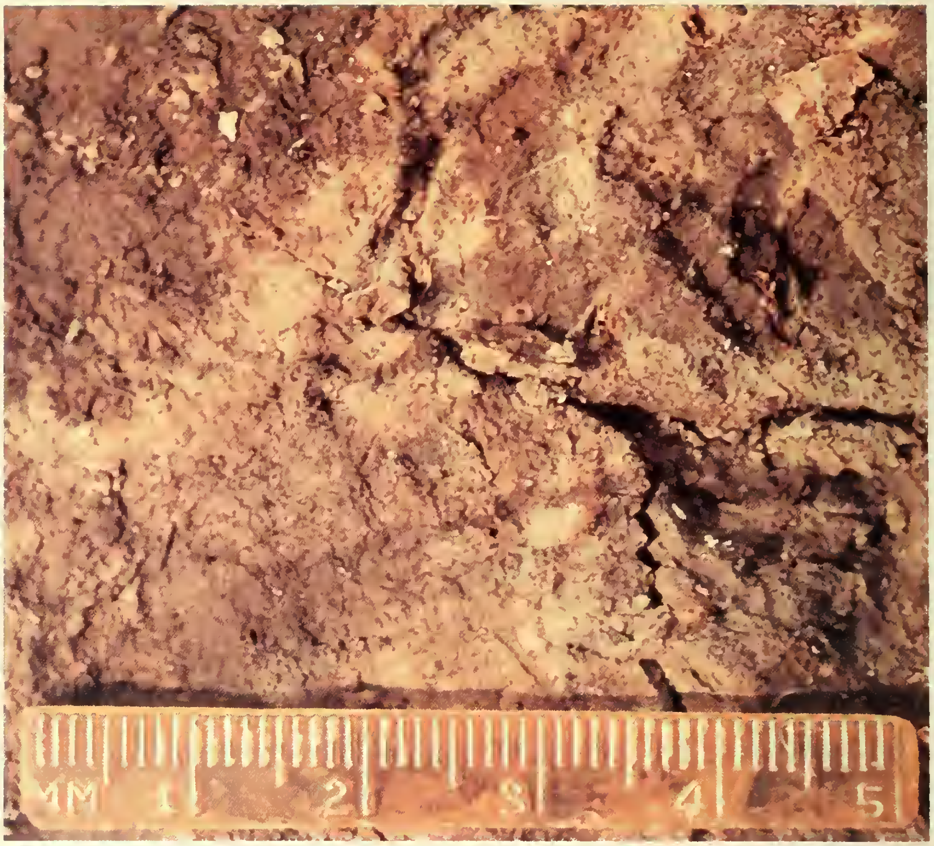

Figure 1. Conspicuous yellow mottles of basic ferric sulphate just below the surface of acid sulphate soils.

Figure 2. Dug up and placed in a pile, the ferric sulphate pieces resemble cat droppings.

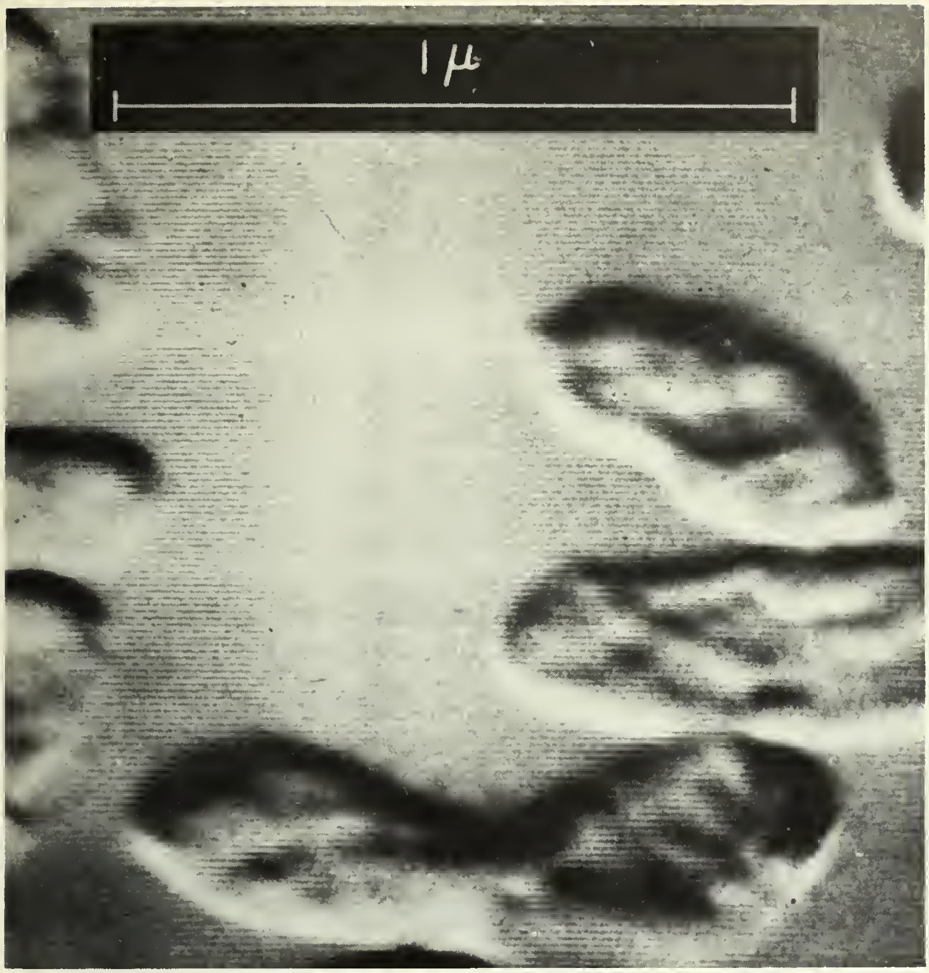

Figure 3. The eating habits of this tiny microbe change sulphur first into pyrite and then into sulphuric acid. This has drastic effects on the soil's productivity.

and through its strange eating habits the sulfur in the pyrite is changed into sulfuric acid by the following reactions:
$2FeS_2$ (pyrite) + $7O_2$ (oxygen) + $2H_2O$ (water) →
$2FeSO_4$ (ferrous sulfate) + $2H_2SO_4$ (sulfuric acid) (1).
$4FeSO_4$ (ferrous sulfate) + $2H_2SO_4$ (sulfuric acid) + O_2 (oxygen) →
$2Fe_2 + (SO_4)_3$ (ferric sulfate) + $2H_2O$ (water) (2).
$3Fe_2(SO_4)_3$ (ferric sulfate) + $11H_2O$ (water) + $2A^+$ →
$2A\ Fe_3\ (SO_4)\ (OH)_6$ (yellow mottle) + $5H_2SO_4$ (sulfuric acid) (3).

Equations (1) and (3) are chemical reactions. However, because in acid conditions the rate of the chemical oxidation of iron is very slow, while that of the bacterium is very rapid, the reaction in equation (2) is mainly bacteriological.

The acid not only makes the soils acid, but also disintegrates beneficial clay minerals such as micas, chlorites, and vermiculites. This process reduces the storage and supply of important plant nutrients, such as potassium, calcium, and magnesium, and it builds up elements such as aluminum and manganese that are toxic to plants. Liming counteracts this process only temporarily and within 1 or 2 years the microbe becomes active again to form more acid. The reactions in equations (1), (2), and (3) are also implicated in the corrosion and heaving of cement foundations and corrosion of pipelines built on soil containing pyrite.

In some areas they have found that the only way to stop this pyrite-munching little creature is to remove its air supply by keeping the land constantly flooded with water. This causes swampy conditions which decrease the acidity by diluting the acid, precipitate the toxic aluminum and manganese, and dissolve the yellow mottles to form sulfates and goethite (rust). Under these conditions another microbe, *Desulfovibrio desulfuricans*, reverses the process. This microbe, which doesn't like air, uses organic matter and the acid to produce hydrogen sulfide (swamp gas) according to the following reaction:
$2CH_3\ CHOH{\cdot}COOH$ (organic matter) + H_2SO_4 (sulfuric acid) →
$2CH_3\ COOH$ (vinegar) + $2CO_2$ (carbon dioxide) + H_2S (hydrogen sulfide) + $2H_2O$ (water). (4)
The hydrogen sulfide then reacts with the rust to form the pyrite.
$2HFeO_2$ (rust) + $3H_2S$ (hydrogen sulfide) + S (sulfur) →
$2FeS_2$ (pyrite) + $4H_2O$ (water). (5)

This research exemplifies the importance of understanding the reactions that cause and counteract adverse soil conditions so that we may use such soils wisely and avoid costly and futile management practices.

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Measuring water content in soil

G.C. Topp

Le taux d'humidité du sol peut être déterminé de façon rapide grâce à l'utilisation d'un appareil mesurant la constante dialectrique ou ses réactions aux ondes radio. Les recherches récentes effectuées sur ce sujet et leur mise en pratique sont décrites dans le présent article.

The water content in soil can be determined conveniently and rapidly by using a cable tester to measure the soil's dielectric constant, that is, its ability to store electrical energy. The results are essentially independent of other soil properties, such as salt content and density. The method has many potential applications in agriculture, for example, in helping farmers in dry areas to decide if there is enough soil moisture to seed a stubble crop or to leave the field for fallow. Recent research into this method was jointly conducted by the Geological Survey of Canada's Terrain Geophysics Division and Agriculture Canada's Land Resource Research Institute.

The technique, which applies high

radio frequencies to the soil, is called time-domain reflectometry (TDR). It was developed and refined for the spacecraft industry and the telephone industry which used it to test cables. Hence, since the technology was available, the TDR technique could be applied directly to the soil. The research, aimed at testing the effect of soil factors and designing probes for use in soil and earth materials, has shown conclusively that the technique can be applied to soil to give a rapid and reliable measure of its water content. Potential applications appear to go well beyond those already studied in this research.

Measuring soil water.

The basic principle

Water has a dielectric constant much higher than the other soil components. Consequently, as the soil's water content increases its dielectric constant rises. The speed that electrical signals travel in any material depends inversely on its dielectric constant. Thus the velocity of an electromagnetic pulse decreases as soil becomes wetter. With the TDR technique it is possible to measure the propagation velocity of a voltage pulse along a cable or transmission line. By having the soil act as part of a transmission line, it is possible to measure the propagation velocity of the voltage pulse in the soil. From this velocity one can calculate the soil's water content.

In the field, measurements are made in the soil between and around two parallel wires or rods about 5 cm apart. The soil and parallel wires act as a transmission line during the measurement. The electrical pulse is applied to one end of the wires. The pulse travels in the soil with the wires acting to guide the pulse along the length of the wire and soil combination. A variety of wire and rod designs can be used, depending on the types of measurement required.

A portable hand probe (Figure 1) is used for measuring the water content of surface soils. The probes protruding from the plastic body are inserted into the soil to be measured. The measuring instrument, a TDR cable tester, is plugged into the top of the probes and the measurement takes a few seconds. The portable hand probe and cable tester combination allows measurement at a variety of locations chosen at the time of measurement.

It is also possible to have wires or probes installed in the soil at greater depths. Such transmission lines remain in place and the cable tester is brought to the location for periodic measurement.

A commercially available TDR cable tester is currently used to measure the water content of soil. The cable tester determines the soil's dielectric constant which is converted to water content using results of laboratory research conducted during the earlier phases of the program.

The applicability of the TDR technique

Although different soil types possess many different properties, including differing abilities to hold water, the TDR technique measures the water content in all soil types. The presence of soluble salt or increased clay content causes an increase in electrical conductivity. At radio frequencies where the TDR technique works well, the dielectric constant is independent of the electrical conductivity. It is only the amount of water which determines the dielectric constant of any soil. Under field conditions the accuracy of measurement gives values within 2 percent of the soil's water content. This is as good as or better than any other available technique.

The TDR technique measures the total amount of water present, regardless of its location along the transmission line in the soil. Hence, the TDR measures equally as well when heavy rainfall has occurred after a prolonged dry period as when water content conditions change more gradually. Under certain conditions it was possible to trace the depth of rainfall or irrigation penetration into the soil.

Successful application of the TDR technique to measure water content depends on the development of an instrument to replace the currently used cable tester. The soil probes, al-

though simple, will be improved as more experience is gained from their use. A proposal for instrument design and development has been sent out to electronics manufacturing companies. One company has been accepted to develop this instrument in collaboration with government researchers during the next two and a half years.

The applications of a new instrument

An instrument which measures water content has many potential applications in agriculture in addition to those with soil. The importance of stored soil water to the success of spring-sown crops in semi-arid dryland farming is well known. The decisions on whether or not the previous year's stubble fields have enough stored water are usually based on regional conditions for portions of the Canadian and U.S. prairies. A TDR instrument capable of quick and reliable measurements would allow decisions to seed or to fallow to be made for each farm. A good measure of the depth where the soil water is stored can be used to decide the optimum seeding depth when zero or minimum tillage is practised.

Current irrigation practice in Canada does not rely on soil water conditions for irrigation scheduling. In water-short areas such as Israel and California, water-content measurements are used for irrigation scheduling. The TDR instrument would provide a more direct measurement for such irrigation requirements than the currently used tensiometers. It would also be possible to monitor irrigation depth and control both water and fertilizer leaching in intensive production such as market gardening and greenhouses.

The variety of probe designs allows for the use of the TDR technique in most research experiments requiring measurement of the water content in soil. For example, the TDR technique determined the pattern of water extraction by corn plants from large pots of soil in greenhouses. There is now considerable interest in the possibility of using TDR for measuring the water content of grain and forage in bins or wagons.

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Long-term dairy cattle production — a view from mouse experiments

J. Nagai and A.J. McAllister

A farmer will usually keep a cow in his herd for as many years as that cow is productive. The profit that a cow makes for a farmer obviously depends upon that cow's production while it is in the herd (until death or culling). Yet we have little knowledge of how the most profitable herd life may be obtained.

Le rendement des vaches laitières doit s'échelonner sur une certaine période de temps et c'est pourquoi les recherches sont plutôt concentrées sur la production de toute une vie du troupeau laitier. L'article parle aussi de certaines expériences faites avec les souris et qui s'appliquent également aux vaches laitières.

Biologically, long-term milk production consists of several characteristics, including milk yields at different lactations, the time between calvings and the initiation of new lactations (calving intervals), and resistance to mastitis. If two dairy breeds are crossed, will the resulting animals be better, relative to the average production of the parent breeds, in milk yield and calving interval, and consequently in long-term production? To examine this point, the National Cooperative Dairy Cattle Breeding Project (NCDCBP), begun in 1971 at Agriculture Canada's Research Branch, is examining selection and crossbreeding aspects of long-term dairy cattle production. However, because turnover in cattle generations is slow, it will take many years to obtain conclusive evidence.

The mouse is biologically different from dairy cattle. But experiments with mice could lead to the development of breeding principles for long-term dairy cattle production because the breeding principles apply across species. The mouse is being used in Research Branch experiments because it has á more rapid turnover of generations (Table 1) and because of cheaper housing, feeding, and husbandry. Mouse experiments should be efficient in providing a large amount of information on breeding principles per unit of time and cost.

Three lines of mice were developed from each of two populations of different origin. They had increased milk production or increased adult body weight or both in the first parity. (One line was maintained unselected in each population.) The eight lines and their 16 F_1 crosses were used to examine female lifetime (200 days) performance. Females were pair-mated with males from a third population of different origin. Whenever possible, litter size was reduced to nine at birth. Body weight of the litter at weaning (20 days) was used to measure the mother's milk production. Lactation performance was accumulated for each female over the lactations which occurred during 200 days. Lifetime lactational performance was then compared among the 24 groups (8 lines and 16 F_1 crosses). Among the results obtained, the following have potential importance to long-term milk production in dairy cattle:

— F_1 crosses were superior (by an average of 15%) to their parental lines (breeds) in lifetime lactational performance.

— F_1 crosses from lines of different populations were superior to F_1 crosses from lines in the same population in lifetime lactational performance (by 18%) and its component traits: number of lactations (14%) and milk production per lactation (4%).

Table 1. Chronology of lifetime production in the mouse and dairy cattle[a]

Stage	Mouse	Dairy Cattle
	Day	Month
Birth	0	0
Weaning	20	
Puberty	40	
Mating	60	16
1st Lactation	80	25
2nd Lactation	103	38
3rd Lactation	126	51
9th Lactation	260	129

[a]If the generation interval is assumed to be 115 days for the mouse and 3.5 years for dairy cattle, the mouse will turn 11 generations while the dairy cattle turns only one generation.

- Favorable hybrid vigor (heterosis) occurred in lifetime lactational performance and its component traits but only in particular combinations of lines.
- The number of lactations during lifetime (N) was more important than milk yield per lactation (M) in lifetime lactational performance (L); the degree of the association (correlation coefficient) of L was 0.93 with N and 0.25 with M.
- Lines selected for milk production (P) showed similar milk production to lines selected for adult weight (W) during first lactation. However, the lines selected for adult weight showed poor reproduction relative to the lines selected for milk production during lifetime; the number of lactations during 200 days was 6.1 for P and 4.2 for W.

In dairy cattle the number of lactations during lifetime is determined mainly by the cow's reproduction. The importance of lactation number indicates that perhaps more attention should be paid to the calving interval in dairy cattle. The results from the third point indicate that appropriate breeds must be chosen when favorable heterosis in long-term milk production is desired in dairy cattle. The favorable heterosis is desired particularly for calving interval because genetic improvement to reduce the calving interval by selecting cows (and bulls) appears to be very difficult.

In the mouse experiments, various populations (e.g., an F_2 backcross generation) can be produced rapidly to examine heterosis in lifetime performance and its component traits. Population performance under various mating systems (e.g., the repeated hybrid male cross system currently used in the NCDCBP) can be examined in a short time. Genetic parameters (e.g., heritability of lifetime performance and its component traits) can be estimated accurately. These estimates are essential in predicting lifetime performance under various breeding systems. Mouse experiments can also be useful in investigating alternative breeding plans which might be considered in breeding dairy cattle for long-term production. Through the study on alternative breeding plans a particular breeding plan such as the plan in the NCDCBP will be covered.

Although dairy cattle breeding experiments provide much information on the genetic improvement of dairy cattle, the breeding plan studied is limited because of the limits of facilities, manpower, etc. Mouse research can provide the results from multiple breeding plans, leading to the development of meaningful guides for dairy cattle. Dairy cattle and mouse breeding research are complementary efforts of the Research Branch. This system is effective particularly for research on long-term dairy cattle production.

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Potato sprouts and potato wart disease

M.C. Hampson

At Agriculture Canada's St. John's West Research Station we are trying to identify factors that affect the development of the potato wart disease fungus. This could help develop methods of economically controlling the pathogen. The fungus that causes wart disease is called *Synchytrium endobioticum* (Schilb.) Perc. It is an obligate parasite, and its principal host is the common potato. The fungus produces ugly cauliflower-like outgrowths or tumors on stems and tubers (Figure 1). It can also take over the stolon sprout, thereby preventing tubering.

One method of attack is to learn more about how the fungus seeks out and enters into susceptible tissue on the host. *S. endobioticum* remains dormant in the soil as a small, round body called a sporangium; it measures about 50 μ across (Figure 2). Infection in potatoes occurs when the sporangium germinates and releases a host of tiny sperm-like spores. These swim in soil water films and gain entry into the potato. We do not know if this is a random act, alighting on a sprout by chance, or whether the zoospores, as they are called, can 'home-in' on a target area somewhere on a sprout.

Selon de récents travaux effectués à Terre-Neuve sur la tumeur verruqueuse de la pomme de terre, il semble que des dommages causés aux germes, soit par le sol ou d'ordre microbiologique, pourraient provoquer cette maladie.

Figure 1. A potato tuber displaying a sprout infected by the wart disease fungus and showing the 'cauliflower' symptom.

Figure 2. The resting, dormant, sporangium of Synchytrium endobioticum measures about 50μ across. Each sporangium becomes filled with zoospores which infect potatoes on release into wet soil.

The sprout is the principal infection court for *S. endobioticum* when potatoes are freshly set in spring. During an examination of the sprout by scanning electron microscopy (Figure 3), we noticed that small areas of the sprout were eroded, almost as though the outer walls had been worn off. This suggested that local microflora had killed or digested plaques of cells on the sprout. We know that sprouts leak many chemicals. For example, Figure 4 shows a chromatograph of the amino-containing compounds that leak out of a susceptible sprout. We obtained this 'finger-print' by collecting the material in water in a tube set around a sterilized sprout (Figure 5). These chemicals could act as rich food sources for many soil micro-organisms. These micro-organisms

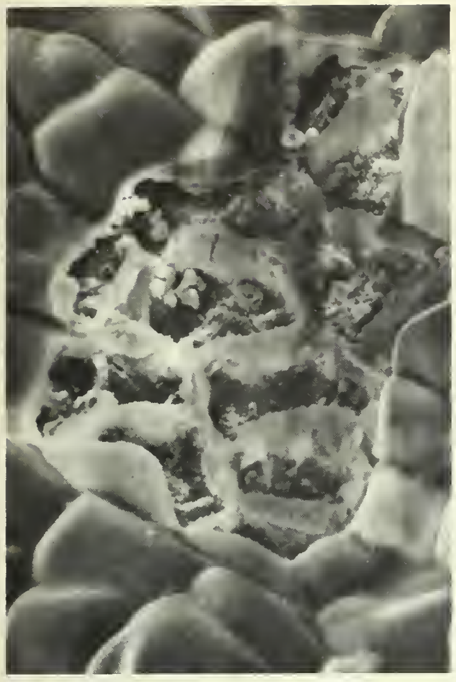

Figure 3. A scanning electron microscope photograph of a potato sprout on which necrotic areas are displayed, magnified about 1000 times. (Photograph is courtesy of Dr. A.K. Bal, Memorial University of Newfoundland.)

Figure 4. Thin layer chromatography 'fingerprints' the amino compounds which leak out of potato sprouts.

Figure 5. Experimental setup designed to collect exudates from potato sprouts.

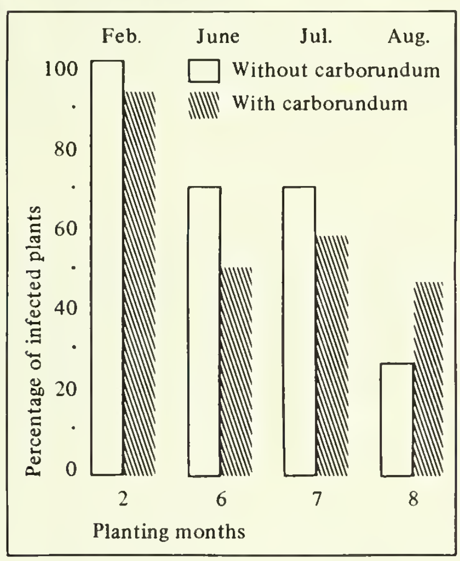

Figure 6. Although the percentage of infected plants falls during the year, the percent infection tends to remain higher when sprouts are rubbed with carborundum powder.

possibly kill sprout areas through their feeding or excretory activities. Several species of Penicillia, for example, have been repeatedly cultured from potato sprouts. *Penicillium* spp. are well known for their chemical exudations and it is probable that active interactions may be occurring between sprouts, Penicillia, and other micro-organisms. We also know that the larvae of the fungus gnat devour potato sprouts in the field, and aid in the fungal infections of other plant species. We have picked off the larvae from wart tumors growing at the base of potato stems. Therefore, in the etiology of wart disease, soil fauna may have an interesting role to play.

To test the theory that necrotic areas on sprouts may be infected by *S. endobioticum*, we gently rubbed some sprouts with a little carborundum powder. The tubers were set in a greenhouse soil bench and irrigated according to the system outlined in an earlier Canada Agriculture article.[1] Equal numbers of treated and untreated tubers were set in winter and summer, and at harvest time parameters such as tuber weight and number, weights of green plant tops, and numbers of infected plants were recorded. In Figure 6 the percentage of infected plants for carborundum treatment is illustrated. It can be seen that carborundum did in fact largely enhance infection. The average percent infections for all treated plants was 65 percent and for non-treated plants it was 61 percent.

Although the results are inconclusive, they bear close examination since they suggest that sprout injury, through whatever means — such as soil abrasion and insect or microbial damage — may be part of the complex of factors which comprise the disease's etiology. It is an interesting commentary on the kind of research effort put into wart disease, since it was identified in the 1880s, that nearly a century later we are still attempting to elucidate the disease's etiological factors. We hope, that through our research efforts at St. John's West, that we will be able some day to tell the whole story of where, how, and why *S. endobioticum* enters a potato sprout. However, like any detective story, it takes time and patience to assemble the clues and to bare the facts.

Dr. Hampson is the plant pathologist at the Agriculture Canada Research Station, St. John's West, Newfoundland.

[1] M.C. Hampson, "Potato Wart Disease in Newfoundland," *Canada Agriculture* 24 (1979) 3:20-23.

Breeding cultivated lowbush blueberries

L.E. Aalders

Cultivation of specially bred, native, lowbush blueberry clones can dramatically increase fruit yield and the efficiency of blueberry crop production. The Agriculture Canada Research Station, Kentville, Nova Scotia, began a breeding program in the 1960s to fully exploit the genetic potential of this crop. The program was based initially on approximately 1000 clones selected from commercial fields throughout Quebec and the Atlantic Provinces. Fruit yields up to 25 t/ha have been obtained in biennial harvests of experimental plots.

The lowbush blueberry, *Vaccinium angustifolium* Ait., is native to northeastern North America. There is evidence of cultivation, especially prune-burning, in prehistoric times. Blue-

berries have comprised a significant portion of the native diet since that time. It is also known that the Indians combined dry blueberry fruit and deer meat to make pemmican—a staple part of their winter diet.

Many native stands of lowbush blueberries in Eastern Canada have been improved by prune-burning in combination with selective weed control. With progressive improvements in commercial operations, the lowbush blueberry is now the region's preeminent fruit crop.

Yields of the cultivated lowbush blueberry vary greatly, depending on such factors as winter injury, frost damage, pollination, water relations, insect damage, disease, and vertebrate predation. There is also a great variation in the yield of clones with age, such that plot yields at Kentville range from zero to more than 25 t/ha (Table 1).

We grew our first seedling populations from open-pollinated fruits from 16 good, select clones in our transplant field. From these we made 12 selections in 1969 (Table 2). Controlled crossing has produced all subsequent seedlings. An average of nearly 4000 of these new seedlings has been produced each year with a selection rate of one superior offspring per 127 new seedlings planted.

For crossing, plants of chosen parents are lifted in October and set in plastic pails. They are stored 4 months at temperatures just above freezing and then brought into the glass-house and forced to flower in February. Since we found it impractical to store pollen, we made crosses from fresh material. As the berries ripen, a waring blender extracts the seeds which are planted in small pots using a 1:1 mixture of peat and vermiculite. When they are about 2 cm high, plants are pricked off into a 1:2:1 mixture of soil, peat, and sand. We sit the new seedlings into 3-in. jiffy pots and let them grow in the greenhouse until late autumn. They are then set outdoors under sawdust or straw mulch and stored until planting the following April or May. They are set to the field at a distance of 1 × 0.5 m, kept reasonably weed free, and grown for 2 ¼ years before selection.

La Station de recherches d'Agriculture Canada de Kentville (N.-S.) mettait en train, en 1960, un programme de reproduction permettant d'exploiter à fond le potentiel génétique des bleuets nains cultivés. Des rendements allant jusqu'à 25 tonnes métriques l'hectare ont pu être obtenus à la suite de récoltes biennales sur des emblavures de la Station. Ce niveau de production a pu être atteint en cultivant des croisements spéciaux de bleuets indigènes à partir d'environ mille clones provenant de terres commerciales du Québec et des provinces maritimes.

TABLE 1. Yields of 16 clones of lowbush blueberry as harvested and as adjusted for plant stand, Kentville, Nova Scotia

Planted in 1971 Clone	1973	1975	1977	1979	4-yr total	Plant stand	Yield adjusted for plant stand
	-		t/ha		-	%	t/ha
ME4161	1	10	12	11	34	68	50.4
ME3	1	10	9	12	32	90	36.0
NB3	-	7	11	8	26	67	38.9
Augusta	1	5	10	6	22	48	45.1
259	-	3	6	10	20	80	24.5
698	-	6	5	6	16	60	26.8
393	-	4	7	4	14	35	41.3
493	-	2	6	2	11	27	40.2
Overall	0.5	5.8	8.1	7.5	21.9	59.4	37.90

Planted in 1972 Clone	1974	1976	1978	1980	4-yr total	Plant stand	Yield adjusted for plant stand
	-		t/ha		-	%	t/ha
70-36	-	15	18	25	58	82	71.4
70-21	-	15	17	24	56	95	58.8
70-28	-	12	13	18	43	87	50.0
70-27	-	9	14	18	41	72	56.7
69-1	-	9	13	15	38	67	56.3
70-64	-	10	10	16	37	82	44.9
70-42	-	5	3	7	15	52	28.2
70-56	-	3	3	5	11	57	20.1
Overall	0.1	9.9	11.3	16.0	37.3	74.2	48.29

TABLE 2. Seedlings and selections evaluated in the Kentville lowbush blueberry breeding program, 1960s to 1980

Origin of seedlings	Seedlings available for selection	Seedlings selected
Native selections	200 000 ± [a]	1000
1969 open	1 920	12
1970 --	6	95
1971 crosses	2 665	20
1972 crosses	4 586	4
1973 crosses	5 328	36
1974 crosses	3 996	29
1975 crosses	5 908	32
1976 crosses	2 244	13
1977 crosses	2 568	20
1978 crosses	5 356	30
1979 crosses	5 464	20
1980 crosses	3 336	30
Total	243 371	1341

[a] Estimate only.
[b] The 1970 selections were taken from the 1969 and 1971 seedling blocks.

At the initial selection stage, plants are propagated by softwood stem cuttings. We give them a 12-plant second test and, if promising, a 4-replicate randomized yield test. The highest trial presently projected before naming is a five-station randomized, replicated, regional yield trial. Three clones have so far been named (Augusta, Brunswick, and Chignecto) and released.

Seedling lowbush blueberry clones are selected in the second year after they have been planted to the field. They are chosen for a composite of characters of which fruit yield, berry size, plant uprightness, and berry flavor are perhaps the most important. The rate of rhizome spread is important too, but is difficult to assess at this early stage.

Disease and insect problems exist in native and developed populations of lowbush blueberry just as with most crops. Twig and blossom blight and blueberry maggot are the most common. These have caused no particular problems in our experimental plots, possibly because of lower humidity and better weed control. Other infected or infested plants are eliminated in the routine selection process. We have as yet used no special methods of breeding for, or identifying,

Photo 1. Rows of 2-year-old lowbush blueberry seedlings at the time of first selection.

Photo 2. Close-up of a fruiting lowbush blueberry.

pest resistance. In future lowbush breeding it may be necessary to use more sophisticated techniques.

With the prospect of a 10 to 20-fold increase in fruit yield, additional problems exist. Rooted cuttings are expensive to produce and about 20 000 are required to plant a hectare. When they are set to the field, frost heaving can cause a large mortality the first year. Heavy mortality does not always occur, but it often does. Large quantities of rooted cuttings are just not available, but the Kentville station will try to supply limited material of named cultivars to plant nurseries on request.

The future of the cultivated lowbush blueberry is indeed bright. Semi-commercial plantings of select clones have been made in all eastern Canadian provinces. These have had variable success for reasons which are not always clear. More research on the cultural aspect of this crop's development is definitely needed. In the meantime, evaluation of the best clones proceeds. Plants have been prepared for replicated yield trials of 16 'ultra-select' clones identified at Kentville during the past 10 years. These include the three named cultivars and represent the most promising blueberry material available. They are to be planted in 1981 in Quebec, Nova Scotia, New Brunswick, Prince Edward Island, and Maine. These trials will also serve as evaluation centers for our preferred cultural techniques and should point out those areas where research on improvements needs to be aimed.

The lowbush blueberry seems best adapted to northern areas where the climate is just too severe for the highbush blueberry. With potential yields of 25 t or more of fruit every other year, it is perhaps the fastest growing horticultural industry in Eastern Canada. We intend to ensure that it maintains that preferred position.

Dr. Aalders is a research scientist with the Agriculture Canada Research Station, Kentville, Nova Scotia.

ECHOES from the field and lab / ÉCHOS des labos et d'ailleurs

EXPORT MARKETS FOR SEED POTATOES Exports of Canadian seed potatoes could double by 1985.

Canada is already a leader in producing high quality seed potato stocks. In the 1979-80 crop year, Canada exported 2.7 million cwt of seed potatoes to 18 countries.

Potential and expanding markets exist in Spain, Portugal, Italy, Greece, Algeria, and Morocco, as well as in the Caribbean and South America.

To cash in on these potential markets, we must ensure that we grow only the highest quality, disease-free seed potatoes that are tailored to the needs of the importers. This means that we must make every effort to eliminate diseases such as ring rot, produce a wide choice of potato varieties suited to the climates of importing countries, and have an aggressive follow-up after sales.

Agriculture Canada, working with the industry and the provinces, has taken steps to improve the phytosanitary control program for seed potatoes to eliminate diseases such as ring rot and to ensure that Canadian seed potato stock is of high quality. This includes more rigorous field inspection to detect any disease and compulsory post-harvest testing.

In addition, the department's research program has been expanded to help develop seed potato varieties that meet the needs of importing countries.

The Canadian Seed Potato Export Agency, better known as 'Potatoes Canada', has been coordinating the export market development activities of seed potato exporters in New Brunswick and Prince Edward Island.

The efforts of the agency in market expansion and in follow-up after sales have improved Canada's position as a leader in seed potato exports.

The potential sales makes the additional money spent in research, quality assurance, and marketing efforts well worth the price. It could translate into exports worth more than $35 million by 1985 for P.E.I. and N.B. seed producers.

CANADA'S MUSHROOM INDUSTRY

Canadians are among the world's most avid mushroom eaters. In the past decade, per capita consumption has risen more than 300 percent and Agriculture Canada economists believe that this growth could continue.

Increased mushroom production in Canada, however, could depend on several factors that the economists have identified. These include growing more mushrooms in areas such as the Atlantic and Prairie Provinces, away from the traditional large fresh mushroom markets, and establishing a national-brand, canned-mushroom product that consumers can identify.

ENERGY SAVINGS IN THE MILKING PARLOR Dairy farmers could save on energy costs by using the heat from milk to warm the water used to wash milking equipment. When milk is cooled for storage, the heat given off is normally wasted. Equipment is now available to capture this lost heat and transfer it to a water tank.

Studies at Agriculture Canada's Engineering and Statistical Research Institute in Ottawa have shown that the milk from a herd of 100 dairy cows produces enough heat to warm all the hot water required in a milking parlor.

PROBLEMS IN MIXING HERBICIDES Tank mixing different herbicides before spraying can result in reduced weed control. Studies at Agriculture Canada's Regina Research Station show that some herbicides are not compatible, and when mixed can be less effective in controlling weeds than either product applied on its own. Mixing can also change the selectivity of the chemicals for crop and weed plants.

To avoid these problems it is best to use only registered mixes and prepare them as recommended in provincial weed control bulletins.

WEED CONTROL IS THE KEY TO DRYLAND WHEAT YIELDS *This note by Dr. S. Greyman and Dr. C.J. Palmer recently appeared in the Weekly Letter from Agriculture Canada's Lethbridge Research Station.*

During the past 18 years, wheat yields on dryland rotations at the Lethbridge Research Station have averaged 29 percent more than for the previous 51 years. Wheat yields in Alberta and across the prairies have followed a similar pattern. To understand why wheat productivity has increased, we recently examined detailed records of changes in weather, soil conditions, varieties, and technology. The introduction of modern herbicides proved to be the major technological change that occurred at the time wheat yield trends shifted upwards.

We began our search with records from research station wheat rotations established in 1912. The cultural practices followed over the years were essentially the same as those recommended to and accepted by the farmers. These practices included ploughing until the early 1920s, discing and frequent cultivations during the 1930s, and stubble mulch farming (blading) since 1939. Broad-leaved weeds were a serious problem until 1950. With the advent of 2,4-D, the weed problem shifted from broad-leaved weeds to wild oats until wild oat herbicides became available. Since the mid-1960s, weeds have been a less serious problem.

During the entire 69-year period, soil nitrogen declined while soil pH increased. The organic matter levels dropped steadily from 1910 until 1922, and then organic matter increased to near the original levels by 1980.

Wheat yields varied widely from year to year, mainly because of wide fluctuations in moisture supply. A noticeable change began in 1963, and since then there has been a distinct increase in yield and moisture-use efficiency. Yield changes were more noticeable on fallow than on stubble and occurred without the use of fertilizers or despite any significant change in climate. Added fertilizer, however, did make the yield increase more pronounced. Improved varieties and machinery could account for only a small part of this yield increase.

The upward trend in yield coincided with the greater ability to control both broad-leaved weeds and wild oats with new herbicides. We therefore conclude that the main factor contributing to the increase in wheat yields since the mid-1960s is improved weed control. Availability of effective herbicides reduced plant competition and permitted shallow seeding into a moist seedbed, improving conditions for plant growth and eliminating numerous spring cultivations, a practice that wastes valuable soil moisture. Since wheat yields across the prairies have followed a similar trend, we suspect that improvements in weed control and consequently in cultural practices are mainly responsible for the general increase in wheat productivity.

FORAGE QUALITY FORECAST To help New Brunswick farmers improve forage production, personnel at Agriculture Canada's Fredericton Research Station recently created a forage quality forecast with the N.B. department of agriculture.

Its purpose is to help farmers harvest their forage at its peak by providing information on the current and predicted nutritional quality of the crops.

Along with this information, a hay-drying index and a 5-day weather forecast provided by Environment Canada are available.

The hay-drying index and 5-day weather forecast are updated three times daily. The value of this forecast became apparent last year when we had an unusually wet summer. The frequent rains made it extremely difficult for the forage to dry and created harvesting problems. Those farmers who followed the forecast, however, harvested before the onset of the wet weather.

This year the station planned to broadcast the information across New Brunswick on CBC radio beginning in the third week of June.

Agriculture Canada Research Station, St. Jean, Quebec

Station de recherches d'Agriculture Canada à Saint-Jean

Dr. C. Aubé, Director.
M. C. Aubé, directeur.

Agriculture Canada's St. Jean Research Station, established in 1952, is the most important center for horticultural research in Quebec. Because large areas of organic soils exist in southwest Quebec, the St. Jean station is responsible for research with these soils.

The St. Jean Research Station is also responsible for research with corn, vegetables, and fruit. Research programs with these plants include management, protection, fertilization, and physiology. For vegetables, research is mainly associated with cole crops, potatoes, and peas. Research is also directed towards fruit trees (apple, pear, plum, and cherry) and to small fruit, like blueberries and raspberries.

La Station de recherches de Saint-Jean-sur-Richelieu établie en 1952 est un centre de première importance de recherches horticoles au Québec. En raison des grandes superficies de sols organiques présentes dans le sud-ouest du Québec, la Station a la responsabilité sur ce type de sols.

Saint-Jean est aussi responsable de la recherche sur le maïs, les légumes, les fruits et les petits fruits. Les programmes sur ces plantes varient de la gestion à la protection en passant par la fertilisation et la physiologie. Chez les légumes, les principaux travaux s'effectuent sur les crucifères, la pomme de terre, le pois; les arbres fruitiers sur lesquels on poursuit des travaux sont le pommier, le poirier, le prunier et le griottier; quant aux petits fruits, nos travaux se limitent aux bleuets (géant et nain) et au framboisier.

Horticultural research at St. Jean.
Recherche horticole à Saint-Jean.

Field plots at St. Jean.
Parcelles de terre à Saint-Jean.

Canada